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Forthcoming Events.

SEPTEMBER 21-26.
Cycle and Motor Cycle Exhibition at Olympia, London.
SEPTEMBER 29.
Institute of Marine Engineers:—Ordinary meeting in London. "Recent Developments in Marine Propelling Machinery." Paper by Andrew I. Nicholson, B.Sc.
SEPTEMBER 28-OCTOBER 2.
Technical-Scientific Associations:—Meeting at Cologne.
OCTOBER 1-2.
The Faraday Society:—General discussion on "Photochemical Reactions in Liquids and Gases," at Oxford.
OCTOBER 2-5.
Smoke Abatement Conference at Buxton.
OCTOBER 2-17.
Textile Machinery and Accessories Exhibition at Manchester.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Secretary: K. S. Bridges, Avenue Chambers, Southampton Row, London, W.C.1.

The Offering of Foreign Foundry Plant in Great Britain.

Undoubtedly, in British Foundry circles, a certain amount of prejudice exists against buying foreign, especially German, plant. But if any type of apparatus enables us, as Britishers, to reduce the ultimate cost of castings, then business of the best international type is being transacted. It is far better to import raw material or machinery for dealing with it, rather than buy finished goods, such as castings.

A number of high-class British engineers have taken up agencies for foundry specialities of German origin. They work on the basis that, having received an order from a British concern, their efforts are then devoted to seeing that the customer gets the full benefit of the conditions which have been specified. This is to be contrasted with a certain number of firms located in countries of war-time neutrality, who are attempting to butt into this trade. We see absolutely no reason why British firms cannot buy either direct from Germany, or preferably through reputable British agencies. We have just received a folder from a Dutch firm, offering a German speciality, *but without disclosing the fact*. The description in English, reminiscent of the notorious poorness associated with bulb catalogues, is so bad as to be unintelligible. If German material is to come into Great Britain, let it come in as such, and not masquerading as Dutch. Some short time ago we saw catalogues emanating in a similar way from Holland, both dealing with the same type of machine, made by two competitive German houses. We have yet to learn that German foundry plant is so cheap that it will stand a commission for Dutch agents, who are obviously not in a position to give service comparable with a British agent. If Holland manufactures anything of real interest for British foundrymen, let them label it distinctly "Manufactured in Holland," as Britishers in general are very hazy as to what is, and what is not, Dutch. There has been some discussion in foundry equipment circles as to whether plant of German origin should be exhibited in the exhibition to be held next June in the Agricultural Hall, London. Our duty is to regard this exhibition from the foundry owners' point of view, and we want British foundries to be cognisant of the machines used in the world's foundries; and, further, if it enables them either to reduce their price of castings or to improve the quality of the output, it is a matter—sentiment apart—of no importance where the plant comes from. From the view-point of the British equipment manufacturers, the showing of German goods enables them to study at leisure the nature of the competition they have to meet, and so duly to arrange their own selling points. British foundry equipment has made rapid strides during the last decade, and many of their machines could usefully be absorbed in German foundries. The Düsseldorf exhibition actually showed equipment made in Great Britain and America.

Summarised, we insist that, where it is advantageous for British foundry industry to buy German plant, they should do so through an established British agency, because such a transaction creates a profit for the British agent, who pays British, and not Dutch, income tax, and the British agent is in a position to give service. German firms having British agents should be allowed to show at the forthcoming exhibition, as it will prevent needless profits going to ex-neutral concerns and establish clearly the countries of origin of various types of machines.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

What is Wrong with British Trade?

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—As malleable ironfounders of over 100 years' standing we are surprised, in view of keen competition prevailing, that your correspondent, Mr. L. Tibbenham, has trouble in getting his wants supplied.

There may be special reasons. The work may be so difficult that malleable founders do not want it, or perhaps your correspondent buys so keenly that the founder cannot live on the price. In these days no founder can afford to experiment unless there is to be a full return for his expenditure.

Regarding delivery, lack of standardisation of patterns causes considerable delay. We could give, if space permitted, specific instances. Buyers delay ordering until it is a case of absolute necessity, and then order *small* quantities to be rushed through by the founder, who cannot take advantage of the speedy machine moulding, but must resort to slow hand moulding.

Frequently the reward of the traders' effort is to wait three or six months for his monthly account, and, as he has to pay for materials promptly, find spot cash for wages and pay heavy taxes, he is crippled in development and improvement, and in many instances has had to close down for lack of the "floating assets" which the other side of the bargain retains to trade on.

Why cannot manufacturers make the same terms as merchants, and charge interest on overdue accounts? If this custom were general, money would circulate and trade keep on the move. Cannot the Chambers of Commerce use their influence in this direction?

Finally, let all promptly pay their way, standardise patterns as far as possible, so helping mass production to reduce costs and give quicker turnover to capital, and we think there would not be so much *wrong* with "British Trade" after all.—Yours, etc.,

THOS. CLIVE & SON, LIMITED.

Staniforth Street, Birmingham.

September 19.

[This letter has been slightly abridged.—ED.]

Colonial and Foreign Foundrymen Leaving for Home.

Prof. Pisek is returning to his home at Brno, Czecho-Slovakia, to-morrow, whilst Mr. Frank O'Niel, of the Western Foundry Company, of Chicago, sailed from Liverpool last Friday. They both made an extensive tour of British foundries, and have asked us to thank the directorates of the following firms for facilities they afforded for inspecting their plants:—

Messrs. Smith, Patterson & Company, Blaydon-on-Tyne; South-Eastern Marine Engineering Company, Wallsend; Metropolitan Vickers, Manchester; Edgar Allen & Company, Hadfields, Limited; Brightside Foundry Company, Sheffield; Markham & Company, Chesterfield; Midland Motor Cylinders, Birmingham Aluminium Company; Pneulec Company, Birmingham; The Rover Company, Coventry, and A. Harper Bean, Sons & Company, Dudley; Ealing Park Foundry Company, London; and Stanton Iron Company, Stanton, Notts.

Mr. Arthur Moore, of the Standard Brass Company, of Benoni, South Africa, sails for home to-morrow. To-night some of his friends are offering him a farewell dinner at the Engineers' Club, Coventry Street. Mr. Moore has asked us to thank the directors of the various works who have accorded him facilities for inspecting their works.

Association of Special Libraries and Information Bureaux.

This new Association, which has its office at 38, Bloomsbury Square, London, W.C.1, holds its second conference at Balliol College, Oxford, next week-end. At the opening dinner (Friday, 7.30 p.m.), the Rt. Hon. Sir Arthur Steel-Maitland, Bart., M.P., Minister of Labour, is to be the principal speaker.

Dr. R. S. Hutton opens the first technical session with a Paper expounding the "Present Position with Regard to the Association of Special Libraries."

Other persons well known to engineering who will contribute Papers are Brigadier-General Magnus Mowat, of the Institution of Mechanical Engineers, who deals with the Institute's library, and Mr. R. Borlase Matthews, consulting electrical engineer, who is dealing with efficient filing. This year no one has yet been announced to speak upon "The Press in Relation to Special Libraries and Information Bureaux," though a session has been allotted to the subject. Prominent amongst the subjects for discussion are:—The League of Nations; Institut Internationale de Bibliographie; The Special Library Movement in America; Technical Intelligence; Abstracting and Translating; Classifying Cataloguing, and Filing; The Special Library and Information Bureau in Relation to Politics, Business, Universities, Mechanical Engineering, Transport and Medicine.

Of Social Interest.

All foundrymen will join us in congratulating Mr. J. G. Pearce, B.Sc., the Director of the British Cast-Iron Research Association, who to-morrow is marrying Miss Mona Rosenhain, daughter of Dr. Walter Rosenhain, F.R.S., the head of the metallurgical department of the National Physical Laboratory. Although Mr. Pearce has only held his appointment a matter of two years, the B.C.I.R.A. has made during his directorate much real progress, and is now inseparably bound up with the progress of cast iron in Great Britain. On behalf of the foundry trades of Great Britain, we offer Mr. Pearce and his bride every good wish for their future happiness and prosperity.

Birmingham Engineers to Have a Club.

After an unsuccessful effort to provide themselves with suitable buildings, Birmingham engineers have entered into an arrangement with the Midland Conservative Club to use their buildings. Birmingham engineers and metallurgists, or those visiting Birmingham at regular intervals who are qualified for membership, may obtain particulars from Mr. A. R. Page, The Laboratory, Messrs. Birmingham Small Arms Company, Limited, Small Heath, Birmingham.

Foundry Query.

Mistimed Boil in Converter Practice.

I operate a small 15-cwt. "Tropenas" converter. When the blow comes on to the final flame in many cases a boil takes place. Can you explain to me its cause and remedy?—R. O. G.

A Good Dusting for Brass-Work Moulds.—In most brass castings it is necessary that they should have a clean face and a fine skin. In the case of light castings, dust the moulds first with pea-meal, and then with a slight covering of plumbago. For heavy work, use only plumbago.

Low Carbon Cast Iron Produced in Cupolas.*

By Dr. Ing Karl Emmel.

Never before in foundry practice has there been such an active endeavour to refine cast iron as during the last few years, and it is noticeable, strangely enough, that during this period of progress numerous articles in journals, both here and abroad—which, together with lectures and discussions—have given rise to a certain confusion in foundry and non-foundry circles which has even partly resulted in serious disputes.

if he uses the correct charge, that is to say, if he modifies the charge in relationship to the thickness of the walls of his castings and their duty. Further processes now exist for the production of pearlitic texture by thermal treatment of moulds and castings, even with an otherwise unsuitable mixture. The wide range of application of these two procedures provides the seed from which this confusion has sprung forth,

TABLE I.—*Tensile Strength and Composition.*

Cast No.	Dia. of bar, in ins.	Tensile Strength tons per sq. in.	Average Composition. Tot. C. Per cent.	Si Per cent.	Mn. Per cent.	P Per cent.	S Per cent.
1	0.787	19.8	2.84	1.96	0.84	0.13	0.140
	0.787	19.7					
	0.787	20.4					
	0.787	20.4					
2	0.590	24.0	2.53	2.44	0.90	0.13	0.170
	0.393	22.4					
	0.590	24.2					
3	0.590	23.7	2.62	2.09	0.96	0.15	0.111
	0.590	25.5					
	0.590	20.0					
4	0.590	26.4	2.70	2.20	1.35	0.20	0.130
	0.590	26.3					
	0.590	26.3					
	0.590	26.1					
5	0.787	20.2	2.66	1.90	0.74	0.26	0.140
	0.787	20.5					
	0.787	20.5					
	0.787	20.5					
	0.787	19.4					
	0.787	18.8					
	0.787	15.6					
6	0.787	18.3	2.51	2.20	0.83	0.18	0.105
	0.787	20.5					
	0.787	19.3					
	0.787	18.7					
7	0.787	20.3	2.48	2.31	1.07	0.18	0.164
	0.787	18.8					
	0.787	20.3					
	0.787	20.0					
8	0.787	18.7	2.69	2.19	0.86	0.11	0.138
	0.787	18.3					
	0.787	20.2					
	0.787	20.2					
9	0.787	20.5	2.80	2.12	1.01	0.13	0.115
	0.787	20.2					
	0.787	20.2					
	0.787	20.5					
	0.787	17.9					
	0.787	25.0					
	0.787	24.4					
	0.787	24.2					
10	0.787	20.0	2.39	2.70	1.04	0.15	0.122
	0.787	20.5					
	0.787	20.5					
	0.787	22.0					
11	0.787	21.8	2.74	2.59	0.70	0.16	0.114
	0.787	20.2					
	0.787	21.3					
	0.787	20.2					
	0.787	19.8					
12	0.787	19.8	2.60	3.29	1.33	0.10	0.104
	0.787	19.5					
	0.787	20.2					
	0.787	19.9					
13	0.787	19.9	2.83	2.06	1.12	0.19	0.780
	0.787	19.8					
	0.787	19.4					
	0.787	19.4					
14	0.787	18.5	2.39	2.73	1.30	0.16	0.074
	0.787	20.2					
	0.787	19.0					
	0.787	19.9					
15	0.787	20.8	2.32	2.82	1.04	0.25	0.106
	0.787	20.8					
	0.787	20.2					
	0.787	20.8					
16	0.787	20.8	2.85	1.94	0.78	0.20	0.114
	0.787	20.8					
	0.787	19.5					
	0.787	19.8					
17	0.787	20.9	2.52	2.38	1.14	0.19	0.082
	0.787	19.5					
	0.787	21.4					
	0.787	21.4					
18	0.787	20.2	2.83	2.07	0.99	0.10	0.100
	0.787	20.3					
	0.787	20.2					
	0.787	20.2					
19	0.787	19.1	2.42	2.68	0.93	0.09	0.088
	0.787	19.5					
	0.787	19.8					
	0.787	20.2					
20	0.787	21.4	2.81	2.19	1.12	0.20	0.085
	0.787	22.0					
21	0.787	14.3	2.40	2.62	0.65	0.16	0.083
	0.787	21.4					
	0.787	19.9					
	0.787	21.2					
22	0.787	18.8	2.66	2.53	1.38	0.19	0.078
	0.787	19.8					
	0.787	20.1					
	0.787	20.4					
23	0.787	20.4	2.86	2.21	1.27	0.19	0.055
	0.787	20.6					
24	0.787	21.6	2.85	2.35	1.02	0.14	0.105
	0.787	21.2					
	0.787	21.2					
	0.787	21.2					

This is all the more difficult to understand in view of the fact that the technical aspect and the practical handling of the subjects concerned have been thoroughly well known for at least 30 years to foundrymen who have made a study of metallography. Thus every cylinder founder is well aware that the texture of his high-duty cast iron is principally pearlitic; in fact, he also knows that pearlitic structure will with certainty be obtained

* Translated from "Stahl und Eisen."

although it is evident that the next and most practicable method will, without doubt, mainly depend upon a proper charge being used.

The knowledge that all high quality cast iron is principally of pearlitic structure, and that still greater possibilities of refining lie in the control of the total carbon content, is of long standing. Even with a carbon content of about 3.2 per cent., the resultant strength and closeness of grain are excellent, yet with a content of 2.5 per cent. to 2.8 per cent. C. the effects are far superior. By

reducing the total carbon the amount of graphite which detrimentally divides up the grain is naturally decreased, so that in the case of cast iron with about 2.7 per cent. total carbon and 0.9 per cent. combined C. (pearlite) only about 1.8 per cent. graphite can be present as compared with a graphite content of about 2.5 per cent. in ordinary carburised cast iron. With less

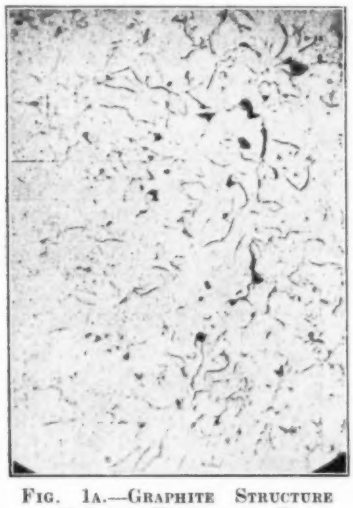


FIG. 1A.—GRAPHITE STRUCTURE × 50 DIAS., TAKEN FROM POINT A, FIG. 5 (6-MM. SECTION).

FIG. 1B.—PEARLITIC STRUCTURE × 500 DIAS., TAKEN FROM POINT A, FIG. 5.

than 3 per cent. carbon the very fine distribution of the graphite is as advantageous a feature as is the presence of only a very small quantity of this latter constituent (Figs. 1A to 3B).

However, cast iron of this nature, which is equally suitable for the controlled production of castings of widely varying types, has up till now only been obtained with reverberatory, oil or

FIG. 2A.—GRAPHITE STRUCTURE × 50 DIAS., FROM POINT B, FIG. 5 (75 MM. SECTION, MIDDLE).

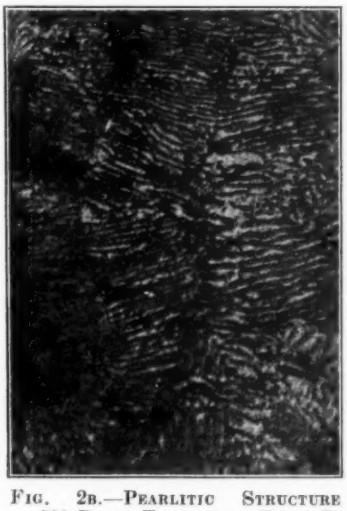


FIG. 2B.—PEARLITIC STRUCTURE × 500 DIAS., TAKEN FROM POINT B, FIG. 5.

electric furnaces, while with a cupola such a result has been only a chance occurrence of no particular importance from a practical point of view.

By means of the Thyssen-Emmel process (patents applied for in Germany and abroad) the problem has been solved of producing in an ordinary cupola a cast iron of total carbon content guaranteed below 3 per cent., such iron, without being subjected to any subsequent treatment, possessing strength properties as shown in Tables I and II. It should first be stated that the nature of the process concerns procedure in cupola working which revolutionises former conceptions and practice.

Up till now, for instance, an estimate for the quantity of coke has been based principally on the melting point of the charge and the degree of fluidity of the melt. For example, if hematite iron, low in carbon content, or high in phosphorus, were charged, a suitably large quantity of charge coke would be chosen in order to ensure hot iron. High furnace temperature has been sought after even at the risk of increased carburisation of the melt due to the greater quantity of coke added. For this reason it was impossible to obtain at will a carbon content of below 3 per cent. in the final product.

According to the invention in question, the coke not only gives a high-temperature iron, but also serves the equally important duty of ensuring a definite low-carbon content which is requisite in the production of high-duty castings; in this respect, of course, other relevant measures in furnace working have to be taken into consideration.

TABLE II.—*Transverse Strengths and Deflection.*

Dia. of bar in ins.	Surface of bar.	Test length in ins.	Transverse strength kg/mm².	Deflection in ins.
0.590 ..	Unmachined	11.8	63.7—73.5	0.18—0.15
0.590 ..	Machined	11.8	64.5—74.0	0.33—0.23
1.180 ..	Unmachined	23.6	60.6—67.8	0.43—0.39
1.180 ..	Machined	23.6	60.0—70.6	0.59—0.39
1.41 ..	Machined	28.3	64.8—66.4	0.65—0.68

In this Paper it is proposed to touch upon a fact which is not widely known, namely, that over-heating the iron in an ordinary cupola is,

on the one hand, only possible to a very limited extent, and, on the other hand, does not depend alone on increased charge coke, for otherwise it would not be possible to obtain iron equally hot with about 8 to 10 per cent. of charge coke as with 12 or 15 per cent.

With regard to these low-carbon contents the amount of silicon must, of course, be increased in proportion in order to procure sufficient graphite separation. Thus the silicon content as shown

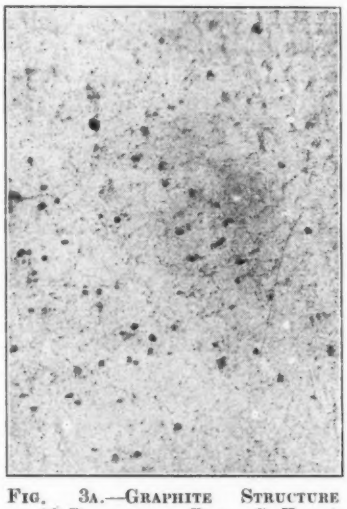


FIG. 3A.—GRAPHITE STRUCTURE × 50 DIAS., FROM POINT C, FIG. 5 (75 MM. SECTION, EDGE).

in Table I varies between about 2 and 2.7 per cent. The average phosphorus content of 0.1 to 0.2 per cent. approaches very nearly that of hematite. On studying closer the analyses given, it will be noted that the best tensile strength values are attained when the quantities of carbon and of silicon lie around 2.5 per cent., and together equal about 5 per cent. The averages for the carbon and silicon contents are, namely, 2.62 and 2.32 per cent. respectively = 4.94 per cent.

In addition to the low total-carbon content and the fine distribution of the eutectic graphite, which separates out to a considerable extent, a further remarkable characteristic of this cast iron is the uniform appearance of fracture in the centre as well as on the edge of a 100 mm. (4 in.) dia. block (Fig. 4, left). A bar of 20 mm. taken from the centre of such a block possessed a tensile strength of 25 kg./mm.² (15.8 tons per sq. in.), thus quite as great as that of a test-bar cast separately of first-class cylinder iron as produced hitherto (Fig. 4, right).

A further noteworthy fact is that this low-carbon cast iron has almost the same fracture appearance in the case of, for instance, a 6 mm. (0.23 in.) thick wall as with 75 mm. (3.0 in.) thickness of wall (Fig. 5). With a ground mass of well-defined pearlitic character, cementite is not present in the thin, nor ferrite in the thicker cross sections, as is shown by Figs. 1B, 2B and 3B: these and Figs. 1A, etc., have reference to the points *a*, *b* and *c* in Fig. 5.

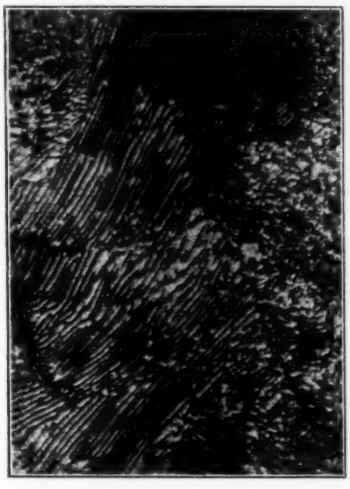


FIG. 3B.—PEARLITIC STRUCTURE TAKEN FROM POINT C, FIG. 5.

Considering the above, and speaking from a practical point of view, one approaches very nearly a single-standard charge—that is to say, a charge which opens out an extensive range of application both in regard to wall thicknesses and to speed of cooling, and this observation, in conjunction with the remarks made above on the subject of texture, covers the possibility pointed out by von Maurer* of producing a cast iron which, independent of cooling conditions to the highest possible degree, possesses a pearlitic ground mass of fine texture and has excellent strength properties.

With a casting as shown in Fig. 5, an additional advantage is apparent in the fact that no pipe formation is noticeable at the otherwise critical points of abrupt juncture of the cross sections, and this constitutes also a valuable feature from the founder's point of view, the more so considering the casting in question was poured in the position as shown.

* Giess. Zeit. 21 (1924), pages 457–63.

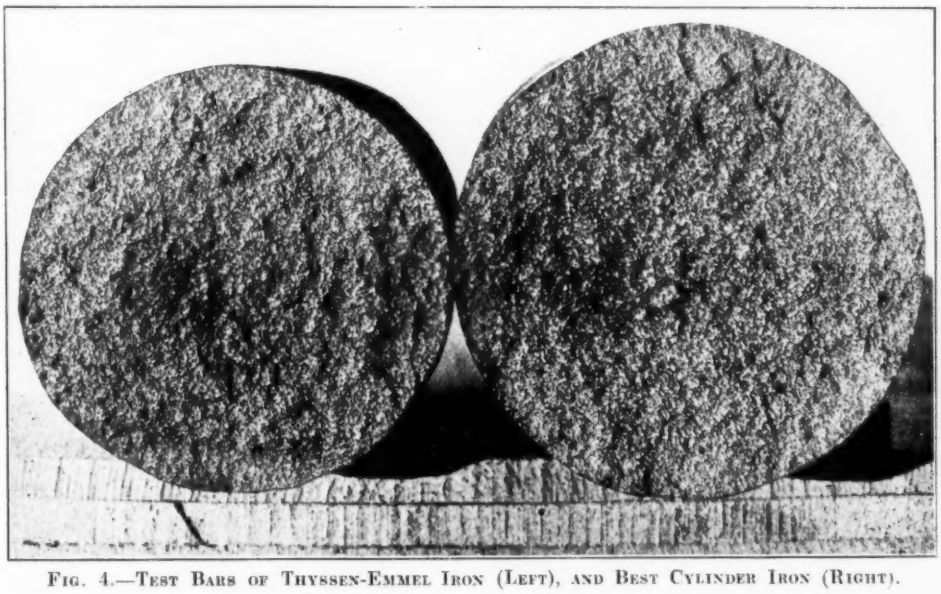


FIG. 4.—TEST BARS OF THYSSEN-EMMEL IRON (LEFT), AND BEST CYLINDER IRON (RIGHT).

This low-carbon cast iron is extremely suitable for machine parts which are subjected to high working pressures. Thus feed-heating chambers as illustrated fractured in Fig. 6 withstood a hydraulic pressure of 200 atmospheres without the free standing walls of even 16.5 mm. (0.65 in.)

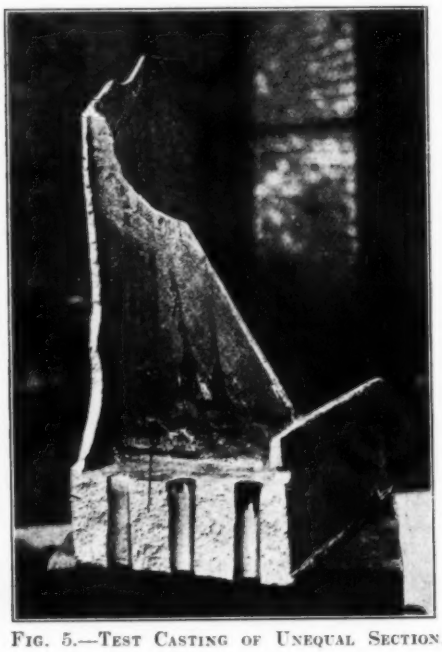


FIG. 5.—TEST CASTING OF UNEQUAL SECTION.

thinness having given way or the water having oozed through at any point. This is undoubtedly quite an unusual performance for cast iron, and allows of a reduction in wall thicknesses which have hitherto been found necessary. As a matter of fact, the cylinder heads shown in Fig. 7 have been reduced in thickness by 20 per cent., and this is an important consideration from the point of view of price, freight and Customs duty.

Further castings weighing individually up to 20 tons are shown in Fig. 7. Particular attention is directed to the cylinder liners and piston rings (Fig. 8) made with this special cast iron; owing to the low carbon content, wearing will be a minimum and the piston rings are of excellent elasticity.

Without doubt this material, with its low carbon and fine graphite contents, would be equally suitable for machine parts holding acids or alkalies.

It has been proved in practice that small castings, such as motor piston rings, etc., can be produced with a cupola of 800 mm. dia. (31 ins.), and also with one of 1,200 mm. dia. (47 ins.), with equal success, and this is not the case with ordinary cast iron. The temperature of the iron in the spout was measured up to 1,480 deg.

While the points touched upon so far have concerned grey iron, which has not been given any subsequent treatment, a few words should be said regarding malleable cast iron containing less than 3 per cent. carbon.

FIG. 6.—FEED HEATER CHAMBER.

Possibilities for Malleable Cast Iron.

As a white iron mixture, this material is suitable for the more economical production of malleable cast iron, according to either the European or the American processes. On the one hand a higher silication occurs owing to the low proportion of carbon in the initial material, and this tends to increase the rate of carbide removal with the result that the annealing period can be shortened. On the other hand, the partial

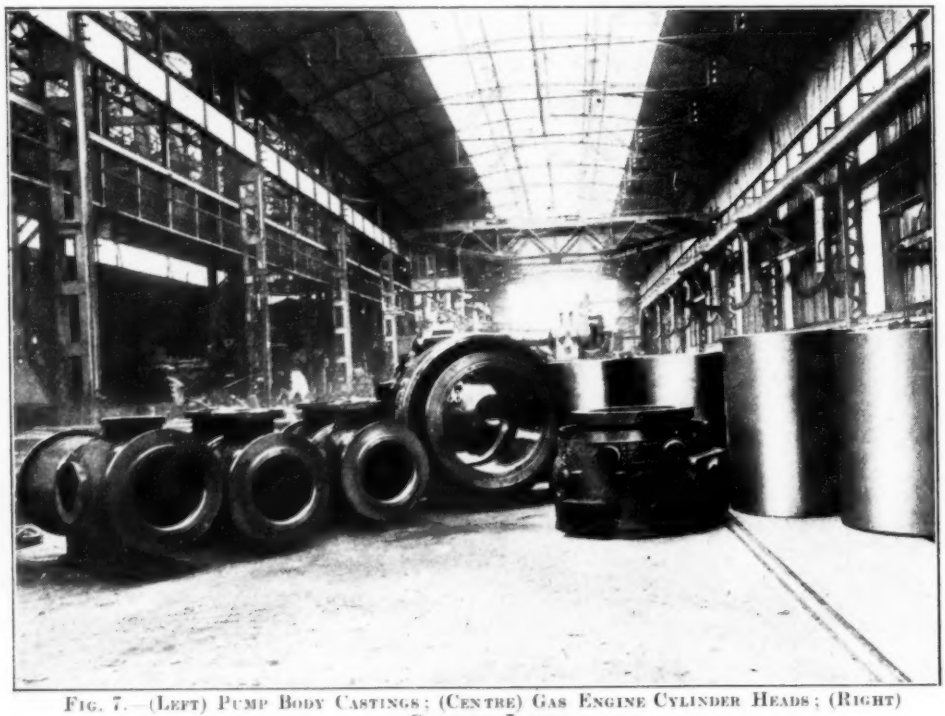


FIG. 7.—(LEFT) PUMP BODY CASTINGS; (CENTRE) GAS ENGINE CYLINDER HEADS; (RIGHT) CYLINDER LINERS.

removal of the carbon has, as it were, already been accomplished owing to the small carbon content in the original material, and for this reason also the period of heat treatment can be decreased. For the American process, cupola melting, in place of the reverberatory furnace, should constitute an economy.

In view of the high production costs of malleable iron, efforts have been meantime made to produce a substance that, with a considerably shorter period of annealing and without utilising malleable material, would possess a tensile strength of 30 to 35 kg/mm² (19 to 22 tons per sq. in.), and an elongation of about 3 per cent. Such a material has been obtained and with the first test a tensile strength of 34.6 kg/mm² (21.9 tons per cent.), and an elongation of 2.5 per cent.

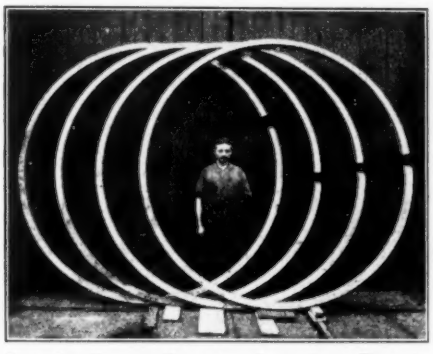


FIG. 8.—PISTON RINGS OF 8 FT. 6 IN. DIAS., AND EACH WEIGHING 6 CWT.

was shown after 13 hours' annealing at 850 deg. The transverse strength of a 15 mm. dia. (0.51 ins.) rod with 300 mm. (11.8 ins.) distance between bearings amounted to 98 kg/mm² (62.2 tons per sq. in.) with 41 mm. (1.6 ins.) deflection. A second melt with altered composition gave, after 20 hours heating at 850 deg., the following values for an untreated rod of 10 mm. dia. (0.39 ins.):—

Tensile strength in tons per sq. in.	Elongation per cent.
35.7	1.8
36.0	1.7
33.7	1.7
26.2	1.4

The transverse strength with rods from the same cast amounted to 112 kg/mm² with a deflection of 10.4 mm. (0.40 ins.) measured on an untreated rod of 15 mm. dia. and 300 mm. (11.8) trial length. These values without doubt open out the possibility of simplifying and rendering cheaper the annealing process, especially the European, practised up till now.

Electric Storage Battery Locomotive Competition.

The Secretary of Mines announces that the judges appointed to adjudicate on the above competition for a prize of £1,000, which was offered by Mr. Charles Markham, of Ringwood Hall, Chesterfield, for the best type of locomotive for use underground in coal mines, have arrived at their decision. They award the whole of the prize to Messrs. Joseph Booth & Brothers, Limited, engineers, Union Foundry and Ironworks, Rodley, Leeds, whose design fulfilled the conditions of entry, and was, in their opinion, the best that was submitted to them.

Belgian Exchange Paper.

The Paper which Mr. J. E. Hurst is reading on behalf of the Institute of British Foundrymen before the Franco-Belgian Foundry Congress at Liège next month is entitled "Notes on the Centrifugal Casting Process, with special reference to the Hurst Ball Process."

Bronze-Welding Cast-Iron Gear-Teeth.

Bronze-welding cast-iron gears is no longer an experiment, and the author has found it to be a dependable, successful process. Experience has shown that the bronze gear-teeth are stronger than the original cast-iron teeth. In a competitive test the bronze teeth held while the cast-iron teeth broke.

An outline or illustration of the procedure may be of benefit to some of the welders out in the field. Recently a 400 lb. gear from an ice-house elevator was brought in for repair. It had twenty-five broken teeth, most of them being broken at the very base of the tooth. First the teeth were cleaned with a wire-scratch brush and then a short piece of pipe was inserted in the hub. Next a piece of chain was passed through the pipe and the gear was hoisted about six inches above the ground. A chain hoist was used. This allowed us to turn the gear, as the occasion demanded, in a vertical position. This was very helpful during preheating and welding.

After raising the gear it was surrounded with an enclosure made of sheet iron and firebrick. The top of this was covered with asbestos paper. The whole gear was then preheated slowly for about four hours. A charcoal fire was used, and the gear was revolved from time to time. This prevented uneven heating and subsequent cracking of the spokes. The paint and grease on the gear smoked quite a bit, but when it finally stopped we started into work. A hole was torn in the asbestos paper, and the gear was revolved until the broken teeth appeared at the hole, one by one. Each tooth was welded in turn.

Bronze-Welding Process.

A piece of carbon is placed on each side of the broken tooth, and the flame of a tip giving a large soft neutral flame is played on the gear until a space about one inch square gets cherry red. At the same time the rod, which has been dipped in flux, is melted and rubbed into the cherry-red spot. If properly done, the bronze will sink or seem to soak right into the pores of the iron. After the foundation of the tooth is laid, the rest of the tooth is built up to the proper height. The carbons are brought closer together at the top and held in position by melting a drop of bronze behind them. When all of the teeth have been welded, the whole is closed, and the entire job is left until the fire has died out and the job cooled off. The next thing to be done is to finish off the teeth. To do this a compass, chalk, square, scratch-awl, and a sheet-iron templet of the correct shape of the teeth are used. In addition a couple of sharp cold chisels and a heavy hammer are needed. The first operation is to cut off the ends of the teeth; these are levelled with the cast-iron ones, then the height of the teeth is corrected with the height of the cast-iron teeth. The correct size is designated by the use of the templet. The author's personal experience with this method of finishing bronze gear-teeth comprises over 300 of them without breaking a single one. The average size of the chip cut is about $\frac{1}{16}$ in.—*Welding Engineer.*

Iron and Steel Output in August.

The National Federation of Iron and Steel Manufacturers report that the production of pig-iron in August amounted to 444,500 tons, compared with 492,700 tons in July and 588,900 tons in August, 1924. There were the same number of furnaces in blast at the end of the month as at the end of July. The August production included 106,400 tons of hematite, 155,500 tons of basic, 131,600 tons of foundry, and 24,800 tons of forge pig-iron.

The production of steel ingots and castings in August amounted to 477,100 tons, compared with 590,400 tons in July (the decrease being partly due to the August holidays) and 527,500 tons in August, 1924.

ISLES, LIMITED, crane makers, of Stanningley, near Leeds, have appointed John Cawley & Company, of 53, Victoria Street, Westminster, as their London agents.

The Magnetic and Electrical Properties of Cast Iron.*

By J. H. Partridge, B.Sc. (Birmingham).

Cast iron has the advantage of cheap production, convenient casting and machining properties, high specific electrical resistance, and consequently lower eddy-current losses. The author reviews past work on the subject, and after outlining his experimental methods, details the influence of several elements on the magnetic properties of cast iron.

As a base two samples of American washed iron were used, one containing 3.16 and the other 3.84 per cent. of combined carbon. In both cases they were free from graphite and contained only traces of manganese and phosphorus, whilst the silicon and sulphur contents were less than 0.05 and 0.02 per cent. respectively.

The alloys shown in Table I were used.

TABLE I.—*Analysis of Alloys Used.*

Specimen.	C.C.	Gr.	Si.	Mn	Al.	Cr.	P.	Ni.	Co.
1	1.88	0.89	0.60	0.01	—	—	—	—	—
2	2.14	0.65	0.80	Tr.	—	—	—	—	—
3*	0.24	2.87	1.43	0.02	—	—	—	—	—
4*	0.35	2.6	1.97	0.02	—	—	—	—	—
5*	0.46	2.28	2.26	0.02	—	—	—	—	—
6*	0.28	2.42	2.46	Tr.	—	—	—	—	—
8	1.46	1.24	2.41	0.04	—	—	—	—	—
9	1.1	1.48	2.74	0.03	—	—	—	—	—
10	1.35	1.19	4.16	0.03	—	—	—	—	—
11	1.35	1.71	2.54	0.02	—	—	—	—	—
12	1.25	1.72	2.87	0.03	—	—	—	—	—
13	1.17	1.80	3.41	0.03	—	—	—	—	—
14	0.88	1.88	4.76	0.05	—	—	—	—	—
15	0.09	2.52	6.04	0.08	—	—	—	—	—
16	0.10	2.30	7.38	0.09	—	—	—	—	—
M1	1.35	1.29	1.72	0.23	—	—	—	—	—
M2	1.38	1.44	1.73	0.63	—	—	—	—	—
M3	1.49	1.20	1.72	1.07	—	—	—	—	—
M4	1.41	1.32	1.70	1.49	—	—	—	—	—
M5	2.65	Nil	1.46	2.66	—	—	—	—	—
A1*	3.06	0.03	0.04	Tr.	0.31	—	—	—	—
A2*	2.96	0.09	0.04	Tr.	0.62	—	—	—	—
A3*	1.34	1.50	0.04	Tr.	1.03	—	—	—	—
A5	1.91	0.65	0.04	Tr.	1.23	—	—	—	—
A6	1.42	1.18	0.04	Tr.	3.00	—	—	—	—
A7	1.35	2.26	0.03	Tr.	0.86	—	—	—	—
A9	1.48	2.15	0.03	Tr.	1.52	—	—	—	—
A10	1.63	1.89	0.02	Tr.	2.23	—	—	—	—
A11	1.34	2.30	0.02	Tr.	2.50	—	—	—	—
A12	1.59	1.91	0.02	Tr.	2.83	—	—	—	—
A13	1.36	2.25	0.02	Tr.	3.60	—	—	—	—
A14	1.57	1.85	0.02	Tr.	4.09	—	—	—	—
C1	1.21	1.38	2.63	0.02	—	0.63	—	—	—
C2	0.94	1.48	3.62	Tr.	—	1.06	—	—	—
C3	1.06	1.39	3.11	0.01	—	1.79	—	—	—
C6	2.10	Nil.	1.71	0.01	—	7.51	—	—	—
P	1.53	1.01	1.67	0.02	—	—	1.86	—	—
N3	1.16	1.40	1.30	0.02	—	—	—	12.35	—
F	0.59	1.61	2.57	2.04	—	—	1.96	10.0	—
Co1	1.28	1.48	2.18	0.04	—	—	—	—	1.86
Co2	1.57	1.34	0.90	0.02	—	—	—	—	6.51
Co4	1.28	1.11	0.66	0.01	—	—	—	—	19.9
Co5	0.83	1.37	0.65	0.01	—	—	—	—	33.33

* Annealed at 900 deg. C. for 15 min.

The results obtained are given in Table II.

As a result of the micrographic examination, it was shown that for the highest magnetic induction and permeability the graphite should exist as temper carbon, and as much ferrite as possible be present.

Graphite in the form of large flakes is not favourable to high induction. For instance, specimen M1 had rather large graphite flakes, which account for its inferior magnetic properties and its high electrical resistance. Additionally the presence of free carbide denotes low magnetic induction, high coercive force, high hysteresis loss and low remanent magnetism.

Specimen F was mainly austenitic, but had a little martensite as well as an intergranular constituent consisting of a mixture of cementite, phosphide eutectic and graphite. Thus the nickel and manganese had produced an austenitic structure, and hence the specimen was non-magnetic. Such a material is extremely hard and difficult to machine. On annealing at 875 deg. C. both this specimen (F) and N3 became martensitic, and consequently magnetic.

* A summary of a Paper read before the Iron and Steel Institute.

Electrical Conductivity.

The specific resistances are given in Table III. All the specimens were in the cast condition, but specimens 3, 4, 5, 6, A1, A2 and A3 had a short heat treatment at 900 deg. C. for 15 min. before turning. It will be seen that aluminium, manganese and phosphorus, all increase the resistances, whilst the specimens F and N3 are exceptional in this direction.

The following conclusions are drawn from the experiments:—

(1) The highest magnetic induction and permeability are obtained with cast iron which has been annealed. In the extreme case the magnetic induction was increased 70 per cent. and the maximum permeability was increased tenfold on annealing.

TABLE III.—*Electrical Properties of Cast Iron.*

Specimen.	Percentage of element.		Specific resistance. Microhms.
1	0.6	Silicon	46.8
2	0.807		50.66
*3	1.43		47.73
*4	1.97		57.15
*5	2.26		60.95
*6	2.46		61.59
8	2.41		74.35
9	2.745		85.41
10	4.165		111.5
*A1	0.31	Aluminium	38.47
*A2	0.62		47.44
*A3	1.03		88.47
A5	1.23		69.56
A6	3.0		89.76
M1	0.235	Manganese	61.94
M2	0.63		59.36
M3	1.07		59.40
M4	1.49		64.95
M5	2.26		66.5
N3	12.35	Nickel	115.9
F	10.00 Nickel, 2.04 Manganese		101.4
P	1.86	Phosphorus	88.7
C1	0.63	Chromium	90.63
C2	1.06		—
C3	1.79		113.5
C6	7.51		64.6

* Annealed at 900 deg. C. for 15 min.

(2) When high permeability is required, the graphite should be in the form of temper carbon, as little combined carbon as possible should be present, and free cementite must be absent.

(3) In the cast state, silicon decreases the magnetic induction, but its presence may be advantageous in alloys which have to work at low flux densities (*e.g.*, transformer cores)). Specimen 15 is an example of an alloy which is very magnetic in comparatively weak fields, having a permeability of over 1,000 C.G.S. at a field strength of 2.0 gauss.

(4) Both in the cast and annealed conditions silicon reduces the coercive force and the hysteresis loss. In the case of specimens 10 and 15, the hysteresis losses are remarkably low, being equal to that of very soft iron. In the case of specimen 15, the low hysteresis loss is remarkable, since it occurs in a cast alloy.

(5) Both in the cast and annealed conditions manganese, nickel, and chromium are prejudicial to high magnetic induction.

(6) In the annealed condition manganese and chromium increase the coercive force and hysteresis loss and decrease the remanent magnetism.

(7) In the cast state aluminium decreases the magnetic induction, permeability, and remanent magnetism, and increases the coercive force and the hysteresis loss.

(8) In the annealed condition aluminium, in amounts up to 1 per cent., decreases the magnetic induction and the maximum permeability, but increases the coercive force and hysteresis loss.

(9) Phosphorus has little effect on the magnetic properties of cast iron, probably tending to increase the magnetic induction in alloys containing silicon.

(10) The presence of sufficient nickel, or nickel and manganese, makes cast iron non-magnetic. Sufficient of these elements must be added to render the iron entirely austenitic, the presence

TABLE II.—*Magnetic and Electrical Properties of Cast Iron.*

Specimen.	B max. (Max magnetic induction.)	H max. (Max magnetic field strength.)	μ max. (Max permeability.)	H for μ max.	Remanent magnetism.	Coercive force.	Hysteresis loss in ergs/c.c. per cycle for B = 10,000.	Watts loss per lb. of metal.
1	9,977	99.5	264	15.1	5,025	—	—	—
2	9,678	99.7	237	16.2	4,733	12.7	34,080	20.08
3 (1) ..	11,480	98.9	481	8.0	5,124	9.8	27,680	15.73
4 (1) ..	11,644	100.13	497	8.0	5,523	8.5	26,120	15.40
5 (1) ..	11,747	100.53	549	6.9	4,578	7.0	23,860	14.09
6 (1) ..	11,900	100.3	737	7.8	4,724	6.5	18,850	11.21
8	11,090	101.4	271	16.0	4,667	—	—	—
9	10,833	101.4	253	16.0	4,431	7.6	20,120	11.86
10	10,540	98.3	254	14.0	4,060	3.5	8,700	5.15
1 (2) ..	10,170	99.4	—	—	—	—	—	—
5 (2) ..	11,480	99.1	—	—	—	—	—	—
10 (2) ..	11,960	99.8	—	—	—	—	—	—
11	10,190	99.7	230	16.4	4,300	12.7	32,435	19.10
12	10,100	100.1	218	16.4	4,290	13.1	32,900	19.42
13	9,845	100.2	213	15.2	3,800	12.0	28,700	16.90
14	9,455	100.1	193	20.5	2,900	9.8	22,840	13.45
15	9,200	99.7	1,021	2.2	2,900	2.2 (3)	4,075 (3)	2.40 (3)
16	8,935	97.3	383	5.9	1,650	—	—	—
M1	10,900	100.1	264	15.0	4,950	—	—	—
M2	11,225	99.9	260	17.2	4,960	—	—	—
M3	11,016	99.5	241	20.2	5,420	—	—	—
M4	10,240	93.9	234	16.6	5,090	—	—	—
M5	8,420	100.0	160	30.0	4,600	—	—	—
M2 (2) ..	11,400	—	—	—	5,930	9.5	28,200	16.6
M3 (2) ..	11,180	—	—	—	5,800	11.0	29,550	17.82
M4 (2) ..	10,560	—	—	—	5,440	12.0	31,600	18.61
A1 (1) ..	10,530	100.1	319	13.2	5,900	—	—	—
A2 (1) ..	10,510	99.1	289	15.0	5,660	—	—	—
A3 (1) ..	9,980	99.5	245	18.0	4,940	—	—	—
A5	8,780	99.2	125	42.7	3,970	—	—	—
A6	7,950	101.0	105	38.5	4,170	—	—	—
A1 (2) ..	10,700	102.7	360	—	6,210	9.9	28,000	16.50
A3 (2) ..	10,370	100.1	312	—	5,760	12.4	36,100	21.26
A5 (2) ..	13,470	99.4	1,045	—	4,800	3.4	9,000	5.30
A6 (2) ..	12,850	100.7	1,030	—	4,600	2.7	7,100	4.17
A7	9,450	98.3	196	19.8	3,850	13.4	31,750	18.70
A10	8,750	98.3	165	20.5	3,580	14.4	30,810	18.15
A12	8,140	93.7	134	26.0	3,040	18.4	39,790	23.24
A14	6,660	98.3	87	41.3	3,210	24.6	41,540	24.47
C1	9,925	97.4	231	15.1	4,460	—	—	—
C2	10,970	96.5	330	13.1	5,150	—	—	—
C3	9,920	99.0	229	17.4	4,160	—	—	—
C6	6,120	99.6	80	45.0	3,310	—	—	—
C1 (2) ..	—	—	—	—	5,550	11.8	31,130	18.70
C2 (2) ..	—	—	—	—	5,290	10.0	29,000	17.14
C3 (2) ..	—	—	—	—	4,960	8.7	24,000	14.15
C6 (2) ..	—	—	—	—	3,350	33.0	45,350	26.75
P	10,970	—	265	—	—	—	—	—
N3	419	99.1	4.6	60	6	—	—	—
N3 (2) ..	3,140	103.2	35.0	57	1,330	—	—	—
F	377	99.6	3.8	60	Nil	—	—	—
F (2) ..	3,280	105.5	33.7	46	1,630	—	—	—
Co1	10,600	97.0	231	16.2	4,700	—	—	—
Co2	10,340	98.3	206	20.3	5,240	—	—	—
Co4	13,095	102.0	266	20.0	6,000	—	—	—
Co5	13,440	96.9	286	21.3	6,100	—	—	—

(1) Normalised. (2) Annealed at 875, surrounded by own turnings. (3) Tested at B = 8,000.

When present in amounts from 1 to 3 per cent., however, aluminium causes a great increase in the induction and permeability, specimens A5 and A6 having inductions of over 13,000 C.G.S. and permeabilities of over 1,000 C.G.S. It also causes a huge decrease in the coercive force and hysteresis loss. The coercive force and hysteresis loss of specimens A5 and A6 are very little greater than those of soft iron.

of martensite making the iron feebly magnetic, hard, and difficult to machine. An easily machinable non-magnetic cast iron could be made by having nickel and manganese present in such proportions that the combined effect of these two elements on the carbon is negligible. Sufficient silicon would then be added to precipitate just sufficient graphite to give the required strength, machining properties, surface, etc.

(11) In the cast state cobalt increases the magnetic induction and remanent magnetism, and increases the maximum permeability. The specimen containing 23 per cent. of cobalt has an induction of 13,440 C.G.S., which is exceptionally high for cast iron in the cast state.

(12) Both manganese and chromium are capable of giving a sufficiently high coercive force for a good permanent magnet, but in doing so they reduce the remanent magnetism to a very small amount.

(13) Silicon, manganese and aluminium raise the specific resistance of cast iron.

(14) Cast iron has a very high specific resistance, and is suitable for resistance grids which have to pass heavy currents.

The Selling of Castings.—XVIII.

BY VOYAGEUR.

One often hears manufacturers discussing catalogues and sales booklets as if they were one and the same thing. They are not, for the catalogue sells more or less passively, whilst the booklet, on the other hand, is active. The former is usually laid aside and retained for purposes of reference. The latter, once it has been read, is generally discarded for good. Therefore it has to argue and convince. It is more of a "printed salesman" than is the catalogue. Its arrangement, policy and problems are all different from those of the full catalogue. Founders who issue sales-booklets often commit the error of overlooking this important distinction. They use up valuable and costly pages on lists of directors, elaborate frontispieces, price-tables, collections of trade-marks, and so forth. This sort of material is quite correct for a catalogue, but it is out of place in a sales-booklet, just as it would be out of place for a traveller to begin his conversation with a buyer by monotonously reciting the names of his firm's directors. The booklet must not waste time. It must set to work to argue and convince at once.

The title is important, as in the case of catalogues. It should be arresting without being undignified. A few examples that come to one's mind are the following:—"When Aluminium Beats Steel"; "Foundry Facts"; "Steel, Electricity, and You." These titles all make the buyer curious to open the booklet, and read at least its first few lines.

The text should not be flippant or familiar. It should have dignity, and should be clear in wording. It is always an advantage to break it up into short, easily readable paragraphs, attractively sub-headed. These sub-titles, scattered up and down every page, should be so designed that even if a buyer reads them alone, and skips the text, he gets in "potted" form the story that forms the substance of the booklet. Sub-titles thus arranged also serve to some extent the purpose of an index.

There is no need to draw striking distinctions between the style of the sales-booklet and that of the catalogue, but it must be remembered that, above all things, the latter should offer convincing arguments, and must be as interesting as it is possible to make it. Exaggeration, misleading statements, must all be avoided. Roughly, the text of the sales-booklet can be divided into seven portions or subjects. The exact order in which these should come will largely depend upon the circumstances surrounding the castings and their character. The following provisional sequence will suit most founders:—(*a*) A discussion or enunciation of immediate problems connected with the employment of the particular class of castings dealt with; (*b*) a description of how these problems can be met by using the particular brand of castings; (*c*) a clear statement, in brief, of the arguments in favour of the castings, with the most important stressed and summarised; (*d*) a more elaborate repetition of these arguments, paragraph by paragraph, each in turn being fully outlined, with examples and proofs; (*e*) notes on price, production facilities, modernity and productive power of the foundry, conditions of payment and delivery, etc.; (*f*) notes on the manufacturer's reputation, on the origin and quality of the raw materials he uses, on the care exercised during the various processes of manufacture so as to ensure the delivery of thoroughly sound castings, on the experience of his staff and workers, etc.; and (*g*) miscellanea, *e.g.*, details of other manufactures; list of agents and representatives, or of dealers; list of other publications issued.

Sometimes, in order to interest the reader and draw him imperceptibly into the story, it is a good plan to open with a brief historical account of the development of the product, but this account must be worth reading for its own sake, as historically interesting. Occasionally, too, it is sound policy to begin the booklet with a short statement or summary of what it sets out to show or prove.

Illustrations for booklets are even more important than those for the catalogue. They must genuinely illustrate the text, and not be stuck in merely to make the booklet look pretty. Furthermore, they must appear in their proper places. It is most exasperating to have to turn over pages in search of an illustration referred to in the text, or to find an illustration on one page that has nothing to do with what one is reading about. The mind is taken off the argument, and often this causes the booklet to be set down and forgotten.

A technical point is worth noting here. If the text mentions the quality of the production plant, the appropriate illustration should be an interior view of the foundry, showing the machines, etc., and not merely a photograph of the exterior of the building. Illustrations should be ordered of a size to suit the size of the booklet, and not *vice versa;* but it must be remembered that, reduced below a certain point, illustrations often lose their effect. Consequently, the point to watch is that the blocks made from them are not so large as to represent a heavy expense, but not so small as to sacrifice their interest and detail.

The way in which the booklet will be distributed will to some extent affect the size of its pages. If it is to be posted, it should be capable of insertion in a standard-sized business envelope, big or little; otherwise special envelopes will have to be ordered, an expense that can be avoided. For distribution by hand, pocket sizes are preferable. If the booklets are to be enclosed in cases or crates, greater variation in size and shape is possible. The page-size should be such that paper is not wasted in attaining it. For example, 6 in. x 5 in. or 9 in. x 6 in. are economical sizes, because in cutting the pages from a standard-sized sheet of paper the margins are not so wide as to represent a heavy waste of paper.

Ridiculous shapes should be avoided, *i.e.*, long and narrow booklets, or those excessively wide, or octagonal, triangular, and so forth. They suggest catch-penny principles. The booklet that stands the best chance of being read is that which looks most like a book or pamphlet. The cover design should be striking, yet not blatant. It should give a hint of the contents, without telling the complete story. In seven cases out of ten, when castings form the subject of the booklet, plain lettering is preferable to a pictorial sketch on the cover. A picture is a dangerous instrument, that often wounds when it seems least likely to do so. The writer remembers one buyer who steadfastly refused to place his orders with a certain firm because of a small (he called it "careless") error of detail in a drawing on the cover of their booklet. His theory was that a firm careless enough to pass an error like that would be careless in its manufacturing methods.

To sum up, it can be said that the booklet is an argument between covers. Usually it is accompanied by a "sales letter," of which more will be said in a later article. It is not intended to be kept permanently, though, of course, no founder will object to such a retention. It is intended to catch the buyer at an opportune moment and pour into his ear the selling points for the castings.

Steel Moulding Sands and their Behaviour Under High Temperatures.*

By A. L. Curtis (Chatteris, Camb.).

(*Continued from page* 216.)

[Unfortunately, the firing of small test-pieces of steel moulding sands in the electric, muffle, or other type of furnace at high temperatures does not give all the required information, as, after firing, such test-pieces become too friable for microscopical examination, or their surface too distorted, to form an accurate view of how the face of such test-pieces (analogous to the face of a mould) withstands the action of the temperature used. For the purpose of this research, refractory tests were carried out by means of a fixed oxygen blowpipe flame, under which the test-pieces were travelled in a horizontal plane. As it was considered desirable to employ a wide range of temperatures for the refractory tests in order to avoid errors in temperature, and accidents due to test-pieces becoming damaged in operation, a range of 1,200 deg. C. to 1,790 deg. C. (Seger cones 6a, 10, 14, 18, 27, 32, and 36) in units of 100 deg. C. was adopted. Standard test-pieces 1 in. x ¾ in. x ½ in. were used, and means were provided for examining microscopically all test-pieces during exposure to the varying temperatures employed. Seger cones ground up and reformed in rectangular fireclay troughs of the approximate sizes 1 3-16 in. x ⅞ in. x ¼ in.) were used as temperature indicators. The period of exposure to each successive heat when taking photomicrographs obviously varied, and different exposures were used for widely differing materials.]

An examination of the photographs of test-pieces of steel moulding sand, Nos. 1301, 1302 (Figs. 8*b* and 8*c*), 1303, and 1304 (Figs. 9*b* and 9*c*), taken during exposure to heat tests, will show that the first three samples resemble each other somewhat closely. It will be seen from these individual photomicrographs, and of Seger cones showing heats reached, that at the lower temperatures the texture of the face of the above three test-pieces is very similar. Also, the texture resulting from complete fusion at about 1,790 deg. C. is closely related. Sand No. 1303 appears to have suffered rather more from heat attack than Nos. 1301 and 1302, possibly due to its higher alkali content.

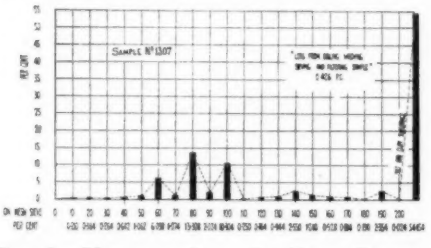


FIG. 7.—MOULDING SAND, ST. ERTH, CORNWALL.

Photomicrographs of sample 1304 indicate that this sand was rather more affected by heat at 1,610 deg. and 1,710 deg. C. than sands 1301, 1302, and 1303. The individual photomicrographs also showed that sand 1304 was denser in texture, which is further confirmed by the group photographs of the test-pieces themselves (Fig. 9*c*). This density, no doubt, was responsible for the cracking shown, caused by an excess of silt and clay substance, viz., 28.86 per cent. compared with 18.751 per cent., the average content of the other three samples.

If, therefore, sands 1301, 1302 and 1303, possessing a texture as shown in the group

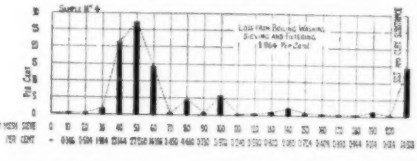


FIG. 7A.—U.S.A. ARTIFICIAL STEEL FACING MIXTURE.

photographs, can successfully produce small and medium weight steel castings from green-sand moulds, and sand 1304 gives bad results, it is reasonable to assume that the difference in texture between 1304 and the other samples is responsible for its failure. On further consideration it will also be seen from the group photographs of test-pieces (Figs. 8 and 9*b* and *c*) that the face of No. 1304 sand is too dense to possess a high degree of permeability, as it would be difficult for steam and gas quickly to find a natural exit from a mould constructed entirely from this sand.

The permeability tests, results of which are given below, show that sample 1304 was considerably less permeable to gas than the other three samples, as when mixed with an equal quantity of sample 1302 (insufficient of sample 1304 being available for test alone), it only gave the low figure of 49.8 as the value for permeability. Below are given the values for P=permeability of the four samples, which will be fully discussed later.

	Sample 1301.	Sample 1302.	Sample 1303.	Sample 1304 (with 50 per cent 1302)
P=	62.1	62.74	50.32	49.8

These values for permeability are in accordance with the variations in the samples shown by the washed residues and photomicrographs.

From the above it might be concluded that of the four deliveries of natural argillaceous sand covering a period of six months during 1913, the first three gave satisfactory results in three different steel foundries, whilst the last delivery was reported unsatisfactory for greensand facing mixtures.

There are, however, experienced steel founders who might reasonably object that the sand represented by the fourth sample, No. 1304, is too strong, and wants breaking down by the addition of silica sand.

Such a statement is true, but it is impossible by the mere feel of a natural argillaceous sand to prescribe the right quantity of silica sand to add to a material like sample 1304, unless it is known beforehand what constitutes the correct strength, texture, and grain-size of the ideal facing sand mixture capable of producing for any length of time sound clean steel castings of given weights. If the ideal mixture was known it would be an easy matter to duplicate it in every-day practice, provided stable sand seams were available, but the grievous number of steel castings suffering from "sand-stick" and other faults is sufficient proof that the ideal has not yet been attained. The obvious treatment by the practical steel founder wishing to use a natural argillaceous sand like No. 1304 would be to add washed silica sand and mix both materials in a pan mill or mixer. Such an admixture would result in reducing the percentage of silt and clay substance, but unless carefully worked out might not overcome the difficulty. Assuming that an equal part by weight of silica sand from the Lower Greensand outcrop at Leighton Buzzard, having a grainsize like sample 92, shown on size diagram (Fig. 10), were added to sand No. 1304, this would reduce the silt and clay substance in the latter from 28.860 per cent., plus loss 3.185 per cent., to 16.751 per cent., leaving the mixture perhaps deficient in bond, and necessitating a further amount of clay substance being added in the form of plastic fire or ball clay. The sand grains in sample 1304 between 90 and 100 mesh, however, would show a strong tendency to clog the pore spaces of those 50 to 60 mesh grains, of which sample 92 is chiefly composed. Thus the addition of an equal part of a high silica sand like sample 92 to sand 1304 would injure rather than improve the resultant mixture.

The chemical analysis of No. 92 (Fig. 10) is as follows:—SiO_2, 97.00; Al_2O_3, 1.48; Fe_2O_3, 0.57; CaO, 0.10; MgO, 0.07; K_2O, 0.11; Na_2O, nil; TiO_2, 0.10; loss on ignition, 0.76=100.19 per cent.

Also, there would be approximately 9.620 per cent. of very fine sand particles, smaller than 100 mesh in the mixture, to contend with, which might tend to reduce refractoriness. Sample No. 1304, therefore, permits of a small addition of silica sand like 92, only for use for small steel

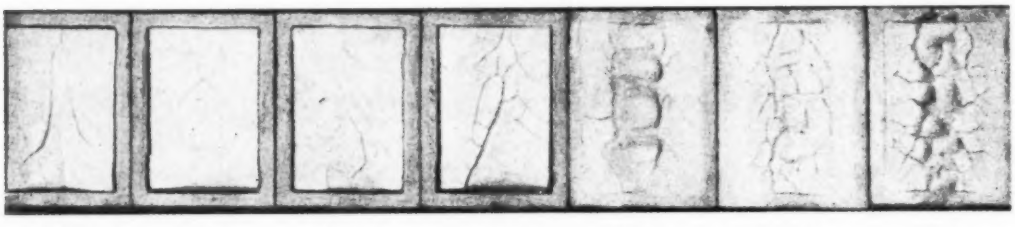
* Carnegie Scholarship Memoir (Iron and Steel Institute).

castings, unless the whole individuality of the sand is going to be altered by adding ball clay and building up the mixture afresh.

As the four samples referred to were taken ten years ago, it would be unwise to arrive at any final conclusion without making surveys from further samples of St. Erth sand, taken from 1913 to the present year. It is therefore proposed to deal with those samples procured between 1914 and 1923, omitting the war period, when the author was absent on active service.

Before proceeding with the natural argillaceous steel moulding sands from St. Erth pits, Cornwall, it is perhaps desirable to refer to the grain-size of artificial steel facing mixtures known to produce successful results in the foundry.

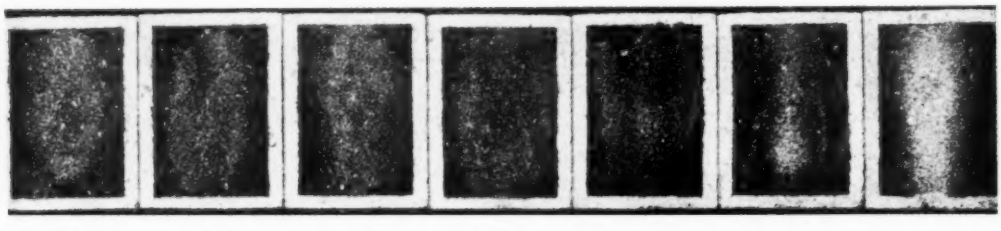
SAMPLE No. 1301.



Cone 6a, 1,200 deg. C., 4 secs. | Cone 10, 1,300 deg. C., 3 secs. | Cone 14, 1,410 deg. C., 2 secs. | Cone 18, 1,500 deg. C., 2 secs. | Cone 27, 1,610 deg. C., 1 sec. | Cone 32, 1,710 deg. C., 1 sec. | Cone 36, 1,790 deg. C., 1 sec.

FIG. 8*a*.—MOULDING SAND (ST. ERTH, CORNWALL).

SAMPLE No. 1301.



After 15 secs. exposure to Cone 6a. | 15 secs. exposure to Cone 10. | 10 secs. exposure to Cone 14. | 8 secs. exposure to Cone 18. | 6 secs. exposure to Cone 27. | 4 secs. exposure to Cone 32. | 2 secs. exposure to Cone 36.

FIG. 8*b*.—SAND, APPROXIMATELY FULL SIZE (ST. ERTH, CORNWALL).

SAMPLE No. 1302.

Cone 6a, 15 secs. | Cone 10, 15 secs | Cone 14, 10 secs. | Cone 18, 8 secs. | Cone 27, 6 secs. | Cone 32, 4 secs. | Cone 36, 2 secs.

FIG. 8*c*.—MOULDING SAND (ST. ERTH, CORNWALL).

The grain-size of such a mixture as used by the Sivyer Steel Castings Company, Milwaukee, U.S.A., viz., sample U.S.A. No. 4, greensand facing, is shown on size diagram (Fig. 7A). This mixture was stated to give very successful results for steel castings produced from the electric furnace. The author's objection to the mixture referred to, as compared with argillaceous greensand facings, was its lack of cohesiveness.

This lack of cohesiveness may have been caused by the small amount of silt and clay substance found to be present, viz. 14.318 per cent. When comparing the size of the above facing mixture, size diagram of sample No. 4 (Fig. 7A), with a well-known English proprietary mixture, like Yorkshire sand, diagram 1970 (Fig. 2), a close resemblance will be noticed in the contour of the respective curves. The reason why sample No. 4 U.S.A. mixture possesses a larger grain-size than 1970, as shown on the diagrams, is because American natural high silica sands are as a general rule larger in size than the English natural high silica sands from the Lower Greensand outcrop either at Leighton Buzzard or at Middleton, Norfolk. The sand grains in the American artificial mixture, being larger and more pure, are capable of lasting longer than the sand grains in Yorkshire sand, as large grains do not disintegrate so quickly as smaller ones, consequently, as "old sand," it can be more frequently used again, if the silt from the burnt clay is sufficiently low, or first removed. The silt and clay substance, however, in No. 4 U.S.A. facing mixture is smaller than in Yorkshire sand by more than 5 per cent., consequently it is less cohesive.

By referring to the chemical analyses of the two mixtures given overleaf, it will be seen that the English mixture has higher alumina and lower silica, which again suggests that the sand contains more clay substance, as borne out by the size diagrams.

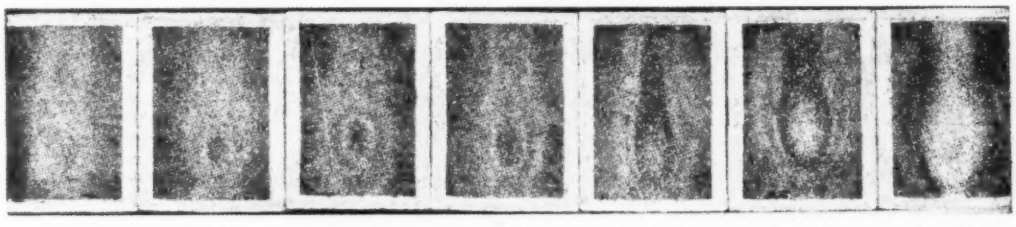
The permeabilities of samples U.S.A. No. 4 and 1970 are shown in a later part of this paper to be 104.8 and 62.8 respectively. These figures therefore confirm the lower silt and clay substance of sample U.S.A. No. 4 shown on the size diagram.

Both the above steel facing mixtures have reputations for producing steel castings in green and dry sand moulds from different types of steel furnace.

The ideal steel facing sand, however, cannot be arrived at without including the Belgian natural argillaceous sands of Pliocene origin. Sample No. 1265 represents a superior variety of Belgian red steel moulding sand from Acoz. This

argillaceous sand is more uniformly graded than any of the previous natural argillaceous varieties. By comparing the size of Belgian sand No. 1265 with U.S.A. No. 4 and Yorkshire sand No. 1970, it will be noticed from the combined size diagram (Fig. 12) that the Belgian sand, whilst occupying the premier position as regards uniformity of grade, is deficient in silt and clay substance, containing only 12.996 per cent. as against 19.350 per cent. in the Yorkshire sand No. 1970 (Fig. 2), and 14.318 per cent. in the U.S.A. No. 4 (Fig. 7A) facing mixture. The inference from this is that Belgian sand is too weak to be used neat for facing purposes.

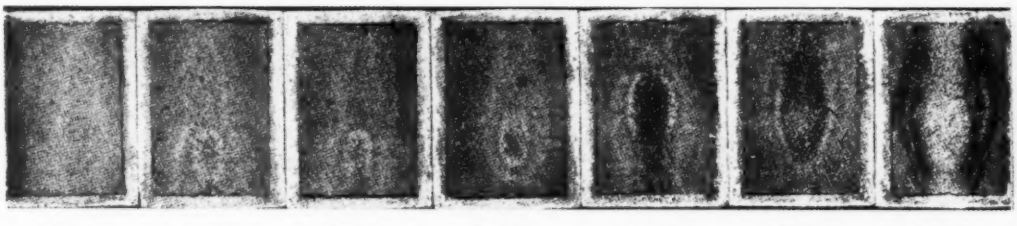
SAMPLE No. 1303.



Cone 6a, 15 secs. | Cone 10, 15 secs. | Cone 14, 10 secs. | Cone 18, 8 secs. | Cone 27, 6 secs. | Cone 32, 4 secs. | Cone 36, 2 secs.

FIG. 9*b*.—MOULDING SAND (ST. ERTH, CORNWALL).

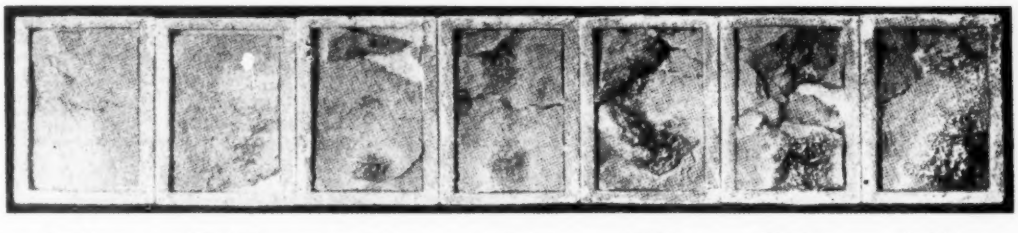
SAMPLE No. 1304.



Cone 6a, 15 secs. | Cone 10, 15 secs. | Cone 14, 10 secs. | Cone 18, 8 Secs. | Cone 27, 6 secs. | Cone 32, 4 secs. | Cone 36, 2 secs.

FIG. 9*c*.—MOULDING SAND (ST. ERTH, CORNWALL).

SAMPLE No. 1316.



Cone 6a, 15 secs. | Damaged face. | Cone 14, 10 secs | Cone 18, 8 secs. | Cone 27, 6 secs. | Cone 32, 4 secs. | Cone 36, 2 secs.

FIG. 9*c*.—MOULDING SAND (ST. ERTH, CORNWALL).

	U.S.A. No. 4 Facing Mixture.	Yorkshire Sand No. 1970.
	Per cent.	Per cent.
Silica	92.16	91.92
Alumina	3.33	4.29
Iron as peroxide	1.14	1.43
Lime	0.16	0.10
Magnesia	0.14	0.06
Potash	0.44	0.15
Soda	0.18	0.05
Titanium oxide	0.53	0.20
Loss on ignition	2.26	1.96
	100.34	100.16
Total fluxes	2.59	1.99

Chemical analysis of sample 1265, however, appears to show that this sand is in other respects a very superior material, viz.:—

Belgian Red Sand (*Acoz*), *Sample No.* 1265.—Silica, 93.08; alumina, 2.94; iron as peroxide, 1.71; lime, 0.28; magnesia, 0.21; potash, 0.36; soda, 0.12; titanium oxide, 0.07; and loss on ignition, 1.18 per cent. = 99.95 per cent.; total fluxes, 2.75 per cent.

By adding 7 to 10 per cent. of fine plastic fire or ball clay to sample 1265, the silt and clay substance would be increased and the sand rendered capable of being used neat, as its large grain-size would give mechanical strength, and the uniformity of its grade would confer high permeability and refractoriness. Practical tests in steel foundry No. 5 confirm that sand No. 1265 gave unsatisfactory results when used neat, even when mixed with other Belgian steel moulding sands.

Reverting again to the Cornish steel moulding sands of St. Erth, from which, as already stated, small steel castings were successfully produced from the Tropenas converter, using hot steel cast in greensand moulds of sand corresponding to sample 1301 used neat, the combined diagram (Fig. 12) gives the relative grain-size of sample 1301, as compared with Belgian sand No. 1265, Yorkshire sand No. 1970, and U.S.A. facing mixture No. 4. From the diagram an opinion might be formed of what should constitute the correct grain-size of the ideal steel facing sand mixture.

It will be noticed that samples No. 1265 and 1301 are natural varieties of argillaceous sands of Pliocene origin, whereas No. 4 U.S.A. and No. 1970 samples are artificial mixtures prepared from silica or argillaceous sands and clays.

On referring again to the diagram (Fig. 12), it will be seen that sand No. 1301 cannot be improved upon without altering its entire individuality, an expense not altogether justified. If

a larger grain-size is desired, and sufficient silica sand added to produce this effect, a proportionate amount of ground plastic fire or ball clay would also have to be added to remedy the loss of clay substance.

Sample No. 1265 could be much improved by the addition of 7 to 10 per cent. of fine plastic fireclay, low in fluxes. Before such an admixture was decided upon, however, it would be desirable to take samples from a large bulk of such sand in order to guard against possible variation in quality, to which Belgian sands are most susceptible.

Unfortunately for the steel founder, sample 1970 is a proprietary mixture, and consequently not available at prices competing with natural argillaceous sands. The grading of sample No. 1970 is not so good as Belgian sand No. 1265, but this could be improved upon. On analysis alone, sample 1970 possesses the lowest total fluxes, with a very small alkali content; No. 4 U.S.A. facing mixture has an advantage in size and shape of grain, the latter being spherical, over either English or Belgian sands. Its clay substance might be increased with advantage, and a better quality fireclay added as bond.

The ideal steel facing sand mixture is therefore not found amongst the above, the nearest approach to the ideal, taking all factors into consideration, being the natural Belgian argillaceous sand No. 1275, which, as already mentioned, is deficient in clay substance.

Unfortunately, only two samples of Cornish sand from St. Erth pits for the years 1914-15, viz., Nos. 1305 and 1319, were available, and there are no reports as to how these sands worked in the steel foundry. Sand No. 1305, sampled in 1914, resembled closely the earlier varieties, Nos. 1301, 1302, and 1303, procured in 1913. On the assumption that the three latter produced good results in the steel foundry, this sand should have produced similar results, especially as the analysis given below shows only 3.10 per cent. total fluxes. It is rather curious that although samples Nos. 1303 and 1305 possess almost identical grain-size, silt, and clay substance content, their alkali percentages differ by 1.42 per cent., that of No. 1303 being the higher, which is not in its favour.

St. Erth Argillaceous Sand (Cornwall), Sample No. 1305.—Silica, 89.48; alumina, 5.27; iron as peroxide, 1.43; lime, 0.20; magnesia, 0.35; potash, 0.59; soda, 0.35; titanium oxide, 0.18; and loss on ignition, 2.18 per cent. = 100.03 per cent.; total fluxes, 3.10 per cent.

A close examination of the group photographs of test-pieces (Fig. 13*b*) of sample 1305 shows that the texture of this sand closely resembles samples 1301, 1302, and 1303. Permeability-to-gas tests (P) show the following:—

	Sample 1305.	Sample 1301	Sample 1302.	Sample 1303.
P =	54.71	62.10	62.74	50.32

as detailed later.

The remaining sample of St. Erth sand, taken in 1915, viz., No. 1319, gave the following analysis:—

St. Erth Argillaceous Sand (Cornwall), Sample No. 1319.—Silica, 85.44; alumina, 7.42; iron as peroxide, 1.57; lime, 0.24; magnesia, 0.16; potash, 0.40; soda, 0.22; titanium oxide, 0.17; and loss on ignition, 4.48 per cent. = 100.10 per cent.; total fluxes, 2.76 per cent.

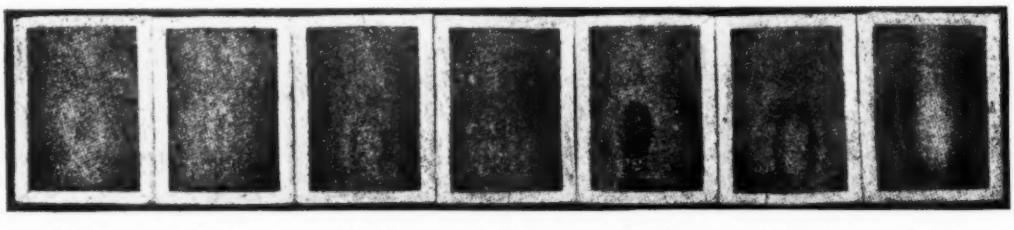
This analysis shows high alumina (7.42 per cent.), low silica (85.44 per cent.), and proportionately high loss on ignition (4.48 per cent.). These determinations would seem to indicate a high silt and clay substance content, yet the latter is only shown to be 23.930 per cent. on the size diagram. This is all the more curious when comparing the above analysis with that of the strong sand No. 1304 (Fig. 6), which latter has a higher silt and clay content, viz., 28.860 per cent., yet the alumina and loss on ignition are shown by analysis to be both lower. Having regard to the above, the chemical analysis of sample No. 1319 might be suspected, considering the fact that the group photograph test-pieces show the texture of this sample to be less dense than sand 1304.

It was not until 1921 that further samples were taken from the pits at St. Erth, when the author again visited the quarries with a view to obtaining a sample of the strongest material possible from the deposit. In July of that year small pieces of the strongest argillaceous sand were picked out of the seams and sampled for test. An analysis from the bulk sample of No. 1306 showed the following figures:—

St. Erth Pits (Cornwall), 1921. *Strongest Argillaceous Sand, Sample No.* 1306.—Silica, 86.72; alumina, 2.56; iron as peroxide, 2.14; lime, 0.10; magnesia, 0.34; potash, 1.04; soda, 0.80; titanium oxide, 0.42; and loss on ignition, 6.24 per cent. = 100.36 per cent.; total fluxes, 4.84 per cent.

As this material only occurred in small patches in the deposit, and was not, in the author's opinion, representative of the rest of the pit, or of any particular seam, its grain-size was not determined, as no useful purpose would have been served. Besides analysing the sample, it was

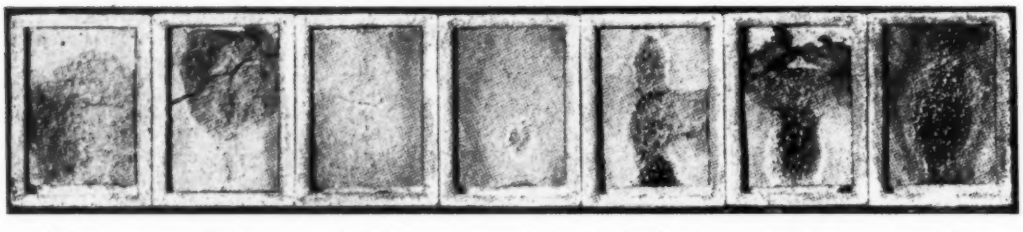
SAMPLE NO. 1306.



Cone 6a, 15 secs. | Cone 10, 15 secs. | Code 14, 10 secs. | Cone 18, 8 secs. | Cone 27, 6 secs. | Cone 32, 4 secs. | Cone 36, 2 secs.

FIG. 9*d*.—MOULDING SAND (ST. ERTH, CORNWALL).

SAMPLE NO. 1314.



Cone 6a, 15 secs. | Cone 10, 15 secs. | Cone 14, 10 secs. | Cone 18, 8 secs. | Cone 27, 6 secs | Cone 32, 4 secs. | Cone 36, 2 secs.

FIG. 9*c*.—MOULDING SAND (ST. ERTH, CORNWALL).

tested for refractoriness. Reference to the group photographs of test-pieces (Fig. 9*d*) will show that this strong argillaceous sand possesses a very dense texture as well as a low fusing point. With such a high loss on ignition as shown in the analysis, a higher alumina content might be expected, as 2.56 per cent. alumina appears to be out of all proportion to an argillaceous sand possessing the great density and high shrinkage shown in the group photographs (Fig. 9*d*).

If some of the 6.24 per cent. given as loss on ignition were organic matter, this might explain the low fusion point of sample 1306, at approximately 1,550 deg. C., as it is not natural to find an argillaceous sand fusing at such a low temperature with only 4.84 per cent. total fluxes.

So far as the total fluxes in sample No. 1306 are concerned, this sand could, if available in

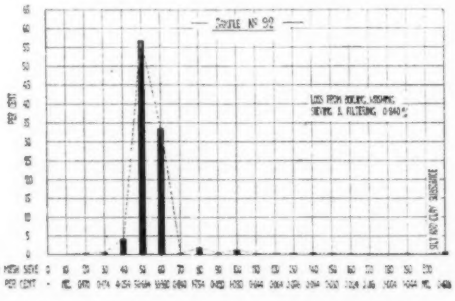


FIG. 10.—ENGLISH NATURAL SILICA SAND, LEIGHTON BUZZARD.

large quantities, be rendered useful, by breaking it down with an addition of high silica sand, but as it only occurs in small patches, has a low fusing point and a questionable amount of organic matter, it is only of interest for test purposes.

When visiting St. Erth in 1921, the author endeavoured to trace a seam of yellow tenacious clay which adjoined the argillaceous steel moulding sand deposit. Samples taken for test purposes showed the following analysis, viz.:—

Yellow Tenacious Clay, Vicarage Pits, adjoining the Argillaceous Steel Moulding Sand Deposit at St. Erth (Cornwall). Sample No. 1316.—Silica, 63.92; alumina, 18.24; iron as peroxide, 3.71; lime, 0.48; magnesia, 0.46; potash, 1.21; soda, 0.88; titanium oxide, 1.05; and loss on ignition, 10.00 per cent.; total, 99.95 per cent.; total fluxes, 7.79 per cent.

On testing sample No. 1316 under the blowpipe, it will be seen from the group photographs of test-

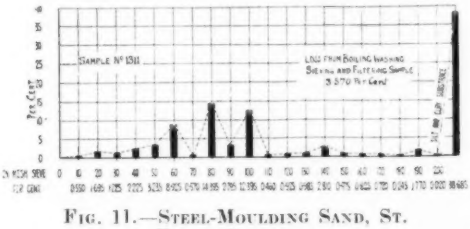


FIG. 11.—STEEL-MOULDING SAND, ST. ERTH, CORNWALL.

pieces (Fig. 9*e*) that this material fused at a relatively lower temperature than cone 14, viz., approximately 1,410 deg. C. This weakness and the high total fluxes it contained, plus its very high loss on ignition, does not recommend its use even for the bonding of silica sands, when more pure fire and ball clays are available for such a purpose. As will be seen from the analysis sample 1316 is really a clay and not a sand, the alumina and loss on ignition being considerably higher and the silica much lower than any previous sample tested, thus removing any doubt on the point. A searching examination of the argillaceous sand-pits at St. Erth failed to reveal traces of any material of this character.

Further samples were taken from bulk deliveries of St. Erth steel moulding sands in August, September, October, and November of 1921. These are dealt with together. During that period eight samples from bulk deliveries were tested. Judging from the size diagrams the samples might be divided into two classes, one where the silt and clay substance content is high, the other representing sands of a weaker character. The strongest argillaceous sands included in Class I are represented by samples Nos. 1307, 1315, 1313, 1311 (Fig. 11), and 1310, whilst Class II consists of sands of weaker character, Nos. 1314 (Fig. 14), 1309, and 1312.

The analyses of the five samples composing the strong Class I gave the figures as shown in the table.

St. Erth Argillaceous Sands (Cornwall). Sample taken in 1921. *Strong Class I.*

Sample Nos.	1307.	1315.	1313.	1311.	1310.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Silica	81.44	80.56	80.32	86.88	86.12
Alumina ..	9.76	9.57	9.25	5.76	6.37
Iron as peroxide	3.43	3.00	3.28	1.86	2.86
Lime	0.18	0.16	0.44	Nil	0.16
Magnesia ..	0.24	0.09	0.49	0.27	0.39
Potash	0.79	1.23	0.87	1.18	0.38
Soda	0.60	0.94	0.65	0.83	0.15
Titanium oxide	0.65	0.55	0.55	0.42	0.37
Loss on ignition	3.12	4.12	4.38	2.90	3.78
	100.21	100.22	100.23	100.10	100.58
Total fluxes	5.89	5.98	6.28	4.56	4.31

By comparing the analyses given above with the size diagrams it was found that as a general rule

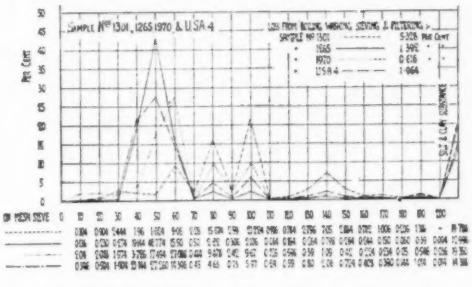


FIG. 12.—COMBINED DIAGRAM OF ENGLISH NATURAL, BELGIAN NATURAL, ENGLISH ARTIFICIAL, AND AMERICAN ARTIFICIAL SANDS.

the higher the alumina the higher the silt and clay substance content shown on the size diagrams. Sample 1310, however, proved an exception to this rule, as although this sand contains 0.61 per cent. more alumina than 1311, yet the latter contains more silt and clay substance. In the author's opinion there is not much difference between sands 1311 and 1310 for use as moulding materials, the alkalies in sample 1311 being nearly

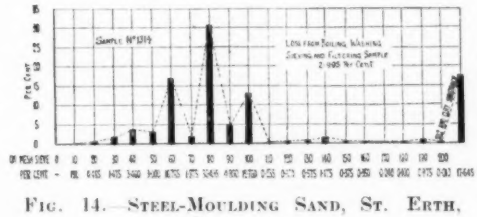


FIG. 14.—STEEL-MOULDING SAND, ST. ERTH, CORNWALL.

counterbalanced by the increased iron in sample 1310.

Although there is a marked similarity in the analyses of samples 1313 and 1315, a slight difference occurs in grain-size and refractory qualities. A wide difference occurs in the permeability of these two sands, viz.:—Sample No. 1313, P= 77.1, and Sample No. 1315, P = 109.4, which is confirmed by the difference in crushing strength, viz.:—Sample No. 1313, crushing strength = 48.68 lbs. per cub. in.; and Sample No. 1315, crushing strength = 37.65 lbs. per cub. in.

Sample 1310 is the most refractory, followed by sands Nos. 1311, 1315, 1313, and 1307, the latter fusing at the lowest temperature.

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Sand 1307, with the highest alumina in Class I, as well as the highest silt and clay substance content (54.154 per cent.), possesses a close texture and a low fusing point. Compared with sample 1310 a great difference in texture after exposure to heats was observed from the photomicrographs.

The chemical analysis of sample 1310 coincides in the main somewhat closely with the only analysis given by Dr. Boswell* of a Cornish (steel) moulding sand. This author defines his analysis as from "a bulk sample of red moulding sand." Both analyses are given below:—

Red Moulding Sand, St. Erth (Cornwall), Boswell.—SiO_2, 86.11; Al_2O_3, 5.29; Fe_2O_3, 2.45; FeO, 0.29; MgO, 0.47; CaO, 0.40; Na_2O, nil; K_2O, 0.95; H_2O + 2.26; H_2O − 1.31; CO_2, nil; TiO_2, 0.34; ZrO_2, trace (0.007); P_2O_5, 0.08; SO_3, 0.03; Mno, trace (0.005); and BaO, nil, per cent.

Argillaceous Sand, St. Erth (Cornwall), No. 1310 (1921).—SiO_2, 86.12; Al_2O_3, 6.37; iron as peroxide, 2.86; FeO, nil; MgO, 0.39; CaO, 0.16; Na_2O, 0.15; K_2O, 0.38; loss on ignition, 3.78; H_2O, nil; CO_2, not determined; TiO_2, 0.37; ZrO_2, not determined; P_2O_5, not determined; SO_3, not determined; MnO, not determined; and BaO, not determined, per cent.

Little difference exists between the above, except in the alumina. The group photographs of test-pieces and photomicrographs of sample No. 1310 showed that a strong argillaceous sand, as represented by either of the above analyses, could not be used alone for facing moulds for steel castings. The nearest approach to Dr. Boswell's figures obtained by the author on Cornish sands from St. Erth are dealt with in samples 1310 and 1311, but photomicrographs of these materials show them to be far too strong to be used neat for steel moulding sands.

On comparing the photographs of test-pieces (Fig. 13*c*) and photomicrographs of the strong argillaceous sand No. 1307 with samples 1314 (Fig. 9*l*), 1309 and 1312, belonging to the weaker class, a much wider difference in texture, density and refractoriness was noticed compared with the differences found between the samples of the strong Class I. On analysis, the three samples composing the weaker class of sands sampled in the last five months of 1921 gave the following figures:—

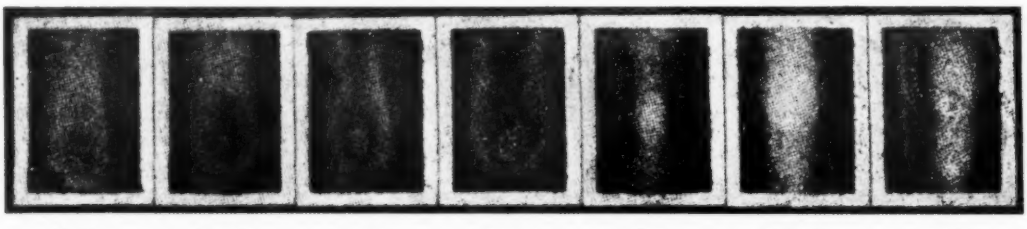
A cursory examination of the above analyses might lead to the supposition that sample No. 1312, with 5.96 per cent. alumina, should be included in the stronger group of sands, especially if No. 1311 (Fig. 11), containing only 5.76 per cent. alumina, was included in that category.

St. Erth, Cornwall, Argillaceous Sands. Sampled 1921. *Weak Class II.*

	Sample 1314.	Sample 1309.	Sample 1312.
	Per cent.	Per cent.	Per cent.
Silica	88.40	89.40	88.36
Alumina	4.11	4.25	5.96
Iron as peroxide ..	2.71	2.57	2.57
Lime	0.24	0.08	0.36
Magnesia	0.16	0.14	0.23
Potash	1.32	0.60	0.60
Soda	1.00	0.41	0.36
Titanium oxide ..	0.22	0.22	0.27
Loss on ignition ..	2.08	2.42	1.44
	100.24	100.09	100.15
Total fluxes ..	5.65	4.02	4.39

The size diagram of 1312 shows this sand to be stronger than the earlier samples 1301, 1302, and 1303, but weaker than sand 1304 taken in 1913. The photographs of test-pieces of samples 1312 and 1311 showed sand No. 1312 to possess an open porous texture compared with the close dense texture of sand 1311.

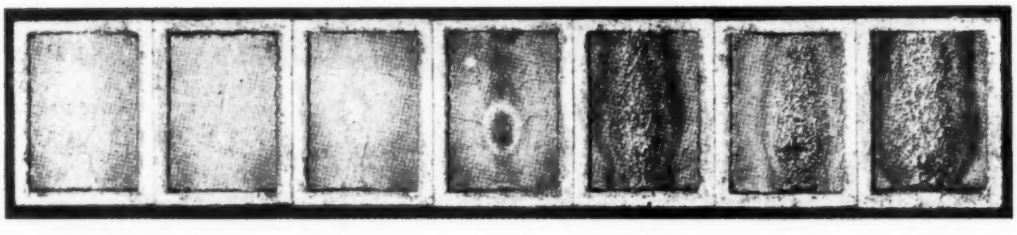
SAMPLE NO. 1305.



Cone 6a, 15 secs | Cone 10, 15 secs. | Cone 14, 10 secs. | Cone 18, 8 secs. | Cone 27, 6 secs. | Cone 32, 4 secs. | Cone 36, 2 secs.

FIG. 13*b*.—MOULDING SAND (ST. ERTH, CORNWALL).

SAMPLE NO. 1307.



Cone 6a, 15 secs. | Cone 10, 10 secs. | Cone 14, 10 secs. | Cone 18, 8 secs. | Cone 27, 6 secs. | Cone 32, 4 secs. | Cone 36, 2 secs.

FIG. 13*c*.—MOULDING SAND TESTPIECES (ST. ERTH, CORNWALL).

	Sample 1314. Per cent.	Sample 1307. Per cent.	
Variation in silt and clay substance	17.645 to 54.154		
Variation in crop of grain-size (−30 to × 100 mesh sieves) ..	73.115	,, 34.504	
Variation in:			
Silica	88.40	,, 81.44	
Alumina ..	4.11	,, 9.76	
Iron as peroxide	2.71	,, 3.43	Per cent.
Alkalies ..	2.32	,, 1.39	(sample 1310, 0.52)
Loss on ignition	2.08	,, 3.12	(sample 1313, 4.38)
Permeability (when mixed with 50 per cent. standard 40 × 50 silica sand)	..137.0	,, 55.1	

As in the stronger so in the weaker class, the general rule seems to be, the higher the alumina and loss on ignition, the greater the silt and clay

* "British Resources of Refractory Sands," 1918, p. 131.

substance. This is borne out by the figures of chemical analysis and size diagrams.

From the foregoing it may be assumed that deliveries of Cornish argillaceous sand from St. Erth pits during the latter six months of 1921 varied between weak sample No. 1314 and strong sample No. 1307. This would represent the following variations, which are of very great importance to the steel founder having to use such raw materials.

The variation in degree of refractoriness and permeability can be better understood by comparing the photographs of test-pieces (Figs. 9*l* and 13*c*) of samples 1314 and 1307.

If the grain-size of the weak sand No. 1314 is compared with that of sample No. 1301 (see diagrams, Figs. 14 and 3), referred to as having in 1913 produced steel castings successfully when used neat in greensand moulds, it will be noticed that the crop of 1314, grains between − 30 to + 100 mesh, is larger than that of 1301, viz.:—

	Sample 1314. Per cent.	Sample 1301. Per cent.
Variation in crop of grain-size (− 30 to + 100 mesh sieve)	73.115 against	54.412

The silt and clay substance in sample 1314 is, however, somewhat smaller, being 17.645 per cent. compared with 19.788 per cent. in 1301. This appears to indicate that good results might be expected from sand 1314. On trial, however (steelworks No. 6), sand No. 1314 gave bad results with castings made from the electric furnace, due, in the author's opinion, to high total fluxes.

The Cornish argillaceous sands from St. Erth, therefore, appear to lend themselves for division into two classes, one strong and dense, the other weak and open. Primarily, the weaker seams dominated, but of recent years the stronger seams appear to be the most worked. The strong sands are, in the author's opinion, incapable of being used alone as facing mixtures, but if mixed with silica sands will produce a reliable steel facing. Latterly, the weaker varieties appear to contain at intervals (see analysis of 1314) too many foreign elements to justify their use neat as facing sands.

It therefore follows that if steel founders are to rely on bulk deliveries of argillaceous sands of Pliocene origin, of which the St. Erth variety is well representative, as being stable from time to time, then steel facing sand mixtures prepared from such raw materials, without previous chemical and physical tests being made, will vary in the same ratio as the raw materials themselves, and consequently produce from time to time indifferent and unsatisfactory steel castings in the foundry.

(To be continued.)

Gazette.

MESSRS. A. E. HARRIS and R. F. ABLETT, brassfounders, Butler's Yard, Broadway, Bexley Heath, trading under the style of Harris & Ablett, have dissolved partnership.

MESSRS. J. DEWAR and W. S. REID, coppersmiths and brass founders, Chipka Street, Poplar, E., trading under the style of Geo. Brockley & Company, have dissolved partnership.

THE TENTER FOUNDRY COMPANY, LIMITED, Ferham Works, Foundry Street, Marsborough, Rotherham, are being wound up voluntarily, with Mr. H. G. Liversidge, Imperial Buildings, Rotherham, as liquidator.

A STRIKE of gratefitters in the employment of Walker, Hunter & Company, Limited, Port Downie Iron Works, Falkirk, has occurred, over 70 men having ceased work. The dispute followed upon the dismissal of a fitter, the men demanding his reinstatement.

THE INSTITUTE OF METALS has just issued its programme for the session 1925-26, which begins in October. Six lectures on metallurgical subjects are to be given during the winter months before each of the Institute's local sections, which are centred, respectively, in Birmingham, Glasgow, London, Newcastle-on-Tyne, Sheffield and Swansea. The programme also includes particulars of the meetings of the parent Institute in London; one of these is the 1926 May Lecture, to be given by Professor H. C. H. Carpenter, on "Single Metallic Crystals and their Properties."

British Industries Fair.

The seventh British Industries Fair, Birmingham, will take place from February 15 to 26, 1926, and will again be housed in the permanent Exhibition buildings at Castle Bromwich. These very commodious and substantial structures are eminently suitable for the purpose, forming the largest exhibition hall in the country, over 170,000 square feet being available for exhibition purposes. Ample transport accommodation is available, inasmuch as the site adjoins Castle Bromwich Station (L.M. & S. Rly.), and has its own sidings alongside the buildings in which the Fair will be held.

The Birmingham Fair will run concurrently with the London section, and immediately prior to Leipzic, so as to enable overseas buyers to visit this country on their way to the Continental Fair.

Birmingham, the home of the Midland section of the Fair, being the centre of a huge industrial area comprising many of the staple industries of the country, is universally admitted to be a convenient place for the exhibition of commodities detailed in the schedule of exhibits, whether the exhibitors carry on their manufacturing operations in the district or in some other part of the country. Situated practically in the middle of the country, it offers exceptional facilities for visiting buyers to get in touch with the "factory behind the article"—a thing which most buyers are anxious to do, in order that they may be better able to explain their wants, and see the possibilities of their being supplied with the best that Britain can produce.

Many of the works are of world-wide fame, and the Birmingham Chamber of Commerce has arranged for parties of buyers to visit those in which they are particularly interested in conducted parties, particulars of which will be announced in due course.

The Birmingham Chamber of Commerce Information Bureau will be pleased to give any information to visitors relative to the industries of the district and of the country, and do everything in its power to facilitate the negotiations for buyers attending the Fair.

It is also intended to invite various trade Associations to make an official visit to the Fair, when facilities will be provided for Conferences if required.

An Australian Steel Foundry Expansion.

The Bradford & Kendall Steel Foundry Company, of Botany Road, Alexandria, Sydney, New South Wales, according to the "Australian Manufacturer," installed a Greaves-Etchell electric furnace some three years ago. We think, however, that the plant was ordered in 1920. Considerable progress has been made, and the output has increased from 5 to 25 tons per week. The firm, however, are installing a Tropenas plant which will increase the capacity to 60 tons per week. Mr. L. Bradford, who created the installation, was formerly open-hearth superintendent at the Broken Hill Steel Works at Newcastle, has now returned to that Company as general manager. Mr. Kendall, who now controls the concern, has had experience with the Dominion Iron & Steel Works in Nova Scotia, the Lackawana Steel Company in Buffalo, and the Broken Hill Company before joining Mr. Bradford.

In addition to the manufacture of castings, a certain amount of special alloy steel is made. The largest casting so far made weighs 2½ tons.

American Foundry Supplies Industry.

According to data collected at the American biennial census of manufacturers, 1923, the firms engaged primarily in the manufacture of foundry supplies reported a total output valued at $10,247,864 of which amount $6,196,293 represents foundry facings, core compounds and core oil, $769,421, chaplets; $516,013, moulding sand; $338,512, foundry equipment (flasks, sieves, brushes, ladles, etc.); $193,614, flux; and $2,234 oil and other products.

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Trade Talk.

THE UNDERFEED STOKER COMPANY, LIMITED, Aldwych House, Aldwych, London, W.C.2, have orders for 17 travelling grates, 5 U.S. conveyors, 2 Murray tubes, one pulverised fuel plant, 31 stokers, 6 air heaters and 4 arches.

AN ORDER, dated August 24, 1925, has been made by the Home Secretary revoking the provisions relating to first-aid contained in paragraphs 1, 2 3 and 4 in the Welfare Order of October 12, 1917, in regard to blast furnaces, copper mills, iron mills, foundries and metal works.

AS IT WAS FOUND IMPOSSIBLE to raise the sum necessary to establish the Engineers' Club (Birmingham) in its one building, the committee and members have agreed to combine with the Midland Conservative Club, which is situated in Waterloo Street and is quite central. The appointments of the club are excellent, and include a dining hall to seat 150 to 200 people, and several public rooms for lectures and committee meetings of the technical societies in Birmingham.

THE CZECHO-SLOVAK IRONWORKS, particularly the Vitkovice Works, which are catering for the Balkan market, are producing goods at such low prices that the German concerns have abandoned all hope of competing successfully with the Czecho-Slovak enterprises, and have already dropped interest in the Rumanian market. The Belgian ironworks still continue to compete, but are working at a loss, and maintain the first position only by supplying wire. In other kinds of iron Czecho-Slovakia is practically the only foreign competitor.

MR. H. G. BLAKEMORE informs us that early in April he tendered his resignation as general manager of the Ransome Machinery Company (1920), Limited, and that the resignation became effective in August. Pending completion of his final arrangements, he has taken temporary offices at 180, Piccadilly, London, W.1. (Telephone No. Gerrard 8263), where he is organising an agency business in connection with machinery, plant and materials of interest to collieries, iron and steel works, contractors, builders, municipal engineers and quarry owners.

A VISIT of inspection has been paid by members of the Cardiff Waterworks Committee to the new pipe manufacturing plant at Guest, Keen, and Piggots, Limited, East Moors, Cardiff. The plant has been designed to manufacture pipes of any diameter from 14 ins. to 72 ins., and in any length up to 26 ft. The new company was registered on April 25, and the shares are jointly held by Guest, Keen & Nettlefolds, Limited, and Thomas Piggott & Company, Limited, the chairman of the company being Mr. W. R. Lysaght, the two managing directors being Mr. A. Dyson and Mr. W. Simons, and Mr. W. Barker, director.

THE 25th anniversary of the foundation of the Mond Nickel Works was celebrated at Clydach, Glamorganshire, on September 12, and Sir Alfred Mond, M.P., chairman of the company, took the opportunity to unveil a bronze statue to his late father, Dr. Ludwig Mond. Sir Alfred Mond was supported by Mr. Robert Mond, Sir Ellis Griffith, K.C., Lord Erleigh, and others, and about 4,000 of the employees and their families were present. Sir Alfred spoke of the scientific discovery that laid the foundation of the works, and said that nickel was one of the handmaidens of modern metallurgical practice, and the combination of steel, chromium, and other metals had developed a series of new metals that would revolutionise engineering by providing alloys of great strength, capable of withstanding very high temperatures and only slightly subject to corrosion. He also paid a tribute to the memory of his father, as one of the greatest figures in industrial science of his generation.

THE CONTRACT for the reconstruction of the Valley Bridge has been awarded by the Scarborough Corporation to John Butler & Company, Limited, Stanningley Ironworks, Leeds, at a cost of £148,000. The work embraces 600 ft. of steelwork, comprising four spans each of 150 ft., carrying a roadway 40 ft. wide and two 12-ft. footways. Another important bridge contract, says "Modern Transport" has been received by the Cleveland Bridge and Engineering Company, Limited, of Darlington, from the Corporation of Poole, Dorset, this being for the construction and erection of a bascule lifting span bridge over Poole Harbour consisting of two leaves of 60 ft. span with two 100 ft. concrete approaches. The bridge will have a roadway 18 ft. wide and two 5-ft. footways. Large orders for bridges in various parts of the Empire have also been placed with Head, Wrightson & Company, Limited, of Stockton-on-Tees. These include the Connaught Bridge over the Klang River for the Federated Malay States Railways, a bridge for the Benguella Railway, Central Africa, and several river bridges in South Africa.

Company News.

British Insulated and Helsby Cables, Limited.—Interim dividend, 5 per cent. on ordinary shares.

Coltness Iron Company, Limited.—Interim dividend on old ordinary shares, 5 per cent., less tax, for year.

Butterley Company, Limited.—Quarterly interim dividend, 4d. per share, free of tax, on ordinary shares.

Sir William Arrol & Company, Limited.—Payment of dividend on 6½ per cent. cumulative preference shares passed.

Thos. W. Ward, Limited.—Final ordinary dividend 6½ per cent., free of tax, making 10 per cent., free of tax, for the year.

Ibbotson Bros. & Company, Limited.—Profit, £14,052; brought forward, £71,476; available surplus, £80,549; dividend, 7½ per cent., tax free, for year; carried forward, £73,543.

Elliott's Metal Company, Limited.—Net profit, £74,145; brought forward, £41,000; dividend for year, 10 per cent. on ordinary shares, less tax; special reserve, £10,000; carried forward, £49,586.

Hardy Patent Pick Company, Limited. — Brought forward, £10,802; net profit, £19,062; total, £29,864; ordinary dividend, 10 per cent. for year, less tax; redemption of debentures £2,500; depreciation of plant, etc., £5,000; depreciation of tools and patterns, £500; carry forward, £11,114.

Palmers Shipbuilding and Iron Company, Limited.—MR. G. MURE RITCHIE, who presided at the meeting of this company, adjourned from December 20, 1924, remarked that the results of recent years were due to the terrible trade depression which had continued so long, and had been accentuated as time had gone on. They were a large company, with interests in many directions, and capable under normal conditions of giving a good account of themselves, but unfortunately there was no branch of their many activities which had not during the period under review felt the dire effects of the most severe slump in business that had ever afflicted this country. Referring to the output of the past 18 months, he reminded them that during nearly five months of that period there was a dispute with the boilermakers over their refusal to honour the overtime, nightshift and holidays national agreement, resulting in delay to the work in hand, as well as loss of earnings by the works during that long period. He only mentioned the matter now to emphasise again the folly of industrial strife, which, as they had learned to their cost, had to be atoned for in far-reaching hardship and suffering. "It is gratifying," he went on, "to be able to add that since that dispute we as a company have been practically free from strikes, although often in fear that demands for higher wages might lead to further stoppages. It is hardly necessary for me to observe that, although this has not occurred, the unrest and uncertainty caused by the possibility of strikes has a deterrent effect upon customers, particularly those in foreign countries, who wish to have a reasonable assurance that they will obtain their ships by the time specified, which is often the sole reason for their placing orders in this country. Continental builders are securing orders that formerly would have come to this country, while, as we know, they have even taken important orders from British owners. They are now building ships abroad on a scale which would never have been dreamt of a very few years ago. We find the rest of the world has more tonnage on the stocks than we have. Whatever may be the reason for this—whether abroad it be lower wages, longer hours worked, more cordial and elastic co-operation on the part of their workmen, less taxation, or a more benevolent and helpful attitude towards the industry on the part of their Governments—the fact remains that we have lost for the time being our historic position as shipbuilders, and are up against foreign competition of a much more determined character than formerly. If we do not want to slip further back, everybody concerned will have to pull together, and bear in mind the simple economic fact that, generally speaking, work comes to that country that produces the cheapest. "I wish it were possible for me," he proceeded, "to express my belief that trade was likely to improve in the near future, but I fear there is to be a period of further waiting before we arrive at that happy state. The revival of trade depends upon so many factors, operating at present very adversely, but with possibilities for a change for the better under altered politics—economic conditions or improved international relationships, that it is difficult to forecast the future. There still exists in many of the countries in Europe a need for material and goods to repair the ravages of the war, as well as the ever-widening markets of our Colonies and other nations following on the natural expansion of the world's needs. The difficulty, however, is to establish means by which we may bring those markets into touch with us and with one another, and thus set the wheels of commerce moving."

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IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—The despondency, previously reported as prevailing in the Cleveland iron trade, continues unrelieved, and so far is without signs of anything like an early improvement in current conditions of the industry. Buying, as has been the case for some time past, is still restricted within the minimum limits of consumers' requirements, and until there is some revival of home demands for foundries, shipyards and engineers, there can be little hope of increased activity in the Tees-side market. On the export side also conditions are equally depressed, shipments from Tees ports so far this month being only about half the total tonnage recorded in August. In the circumstances thus outlined it is not surprising to find that prices indicate a weaker tendency, and although at last week's market sellers nominally adhered to 68s. for No. 3 G.M.B., that quotation could be readily shaded for anything like a substantial order, with No. 1 quality at 72s., No. 4 foundry 67s., and No. 4 forge 66s. 6d. per ton.

While the market for hematite shows but little expansion, the position statistically is somewhat healthier, inasmuch as producers have been able to dispose of the bulk of their stocks, though they state that the prices realised have left no margin of profit. Home demand is, perhaps, a trifle better, but the export position remains dull and unchanged. Sellers, however, are not disposed to make further price concessions, and are adhering to 75s. per ton for East Coast mixed numbers, and 75s. 6d. per ton for No. 1. On the North-West Coast, Bessemer mixed numbers are still quoted at £4 2s. 6d. c.i.f. Welsh ports, £4 5s. at Glasgow, £4 7s. 6d. at Sheffield, and £4 12s. 6d. at Birmingham.

LANCASHIRE.—The local markets for foundry pig continue without material change, the bulk of the business passing being, as usual, confined to prompt lots of comparatively limited tonnage as needs arise. Keen competition is now experienced for any orders in circulation, Lincoln makers being apparently anxious to regain their former standing in the Manchester area, while it is not unlikely that Cleveland iron may soon become a serious rival for favour in this direction. As a rule, makers of Derbyshire foundry iron keep steadily to the price of 74s. per ton delivered local, or 68s. 6d. on trucks at the furnaces. One would not like to say that no less is ever taken, but the concessions are probably limited to 6d. per ton where they are made. In Scotch foundry iron very little is being done locally, but the price remains at 98s. per ton.

THE MIDLANDS.—At Birmingham last week the market for foundry pig was again reported quiet, the demand for heavy castings especially being only on a limited scale. Local ironfounders who have a fair amount of business will not buy forward, as they consider that prices will fall still further, and are still content to carry on as they have been doing for some months, by buying small quantities from time to time. This policy has already proved to their advantage with a dropping market. Ruling prices for pig-iron are as follow:—Derbyshire No. 3 foundry, 66s. to 66s. 6d.; forge, 59s. to 60s.; Staffordshire No. 3 foundry, 69s.; forge, 67s. 6d.; Northants, No. 3 foundry, 61s. 6d. to 62s. 6d.; forge, 57s. 6d.

SCOTLAND.—Business in this area remains in a state of depression, and no change for the better can be noted in the general industrial conditions. Scotch pig-iron makers are, however, very reluctant to reduce their prices, and are still quoting 80s. for No. 3 foundry at the furnaces. There has been more actual shipment for export business, but this is on older contracts. Middlesbrough pig-iron is also very dull and without demand in this area, and all grades are now readily obtained.

Metals.

Copper.—Movements in standard copper have disclosed slight change of late, values having been generally maintained at about the £62 level, which now appears almost a settled basis. Presumably it is not to be expected that values will show much greater strength unless the autumn brings the usual improvement in business conditions. At the same time, the intrinsic position of copper must be regarded as sound, as stocks are nowhere large, although heavier in Europe than America, but the fact remains that they are not excessive in view of the large potential demand which exists. Current quotations:—*Cash*: Thursday, £62; Friday, £61 15s.; Monday, £62; Tuesday, £61 15s.; Wednesday, £61 10s.

Three Months: Thursday, £63; Friday, £62 15s.; Monday, £62 17s. 6d.; Tuesday, £62 15s.; Wednesday, £62 10s.

Tin.—After suffering a somewhat severe relapse a short time since, tin values appear to be recovering from the lower levels recently reached. The rally is probably due to the more favourable statistics for last month, indicating a decrease in the visible supply of about 580 tons, while the American deliveries panned out up to expectations, at over 6,500 tons. The visible supply is now about 1,000 tons under the figures recorded a year ago, but the fact may be pointed out that the controlled surplus which was then in existence has since been dispersed, and, so far as can be gathered, the enlarged production is now only about keeping pace with requirements. Current quotations:—*Cash*: Thursday, £260 10s.; Friday, £260 2s. 6d.; Monday, £262; Tuesday, £261 12s. 6d.; Wednesday, £264 5s.

Three Months: Thursday, £262 10s.; Friday, £262 2s. 6d.; Monday, £264; Tuesday, £262 17s. 6d.; Wednesday, £264 10s.

Spelter.—The position of this metal remains as previously reported, and is undoubtedly healthy, with consumption improving again, while the world-production does not seem to increase, allowing for the recent set-back in Belgium. The demand from galvanisers has been more active, and brass makers are doing a little better. Belgium is not a free seller. Current quotations: *Ordinary*: Thursday, £37 3s. 9d.; Friday, £37 6s. 3d.; Monday, £37 12s. 6d.; Tuesday, £37 17s. 6d.; Wednesday, £38 5s.

Lead.—The market for foreign pig has developed a more active tendency of late, following the recent decline in large scale purchases by home consumers. The intrinsic position of the metal, however, seems to have undergone little change, as a temporary decline in effective purchases in America and Europe cannot be regarded as a serious factor, because users are still very active, and will have to re-enter the market sooner or later.

The following are the week's prices:—*Soft foreign (prompt)*: Thursday, £39; Friday, £41; Monday, £41; Tuesday, £39 17s. 6d.; Wednesday, £39 12s. 6d.

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Caledonian Ironworks,
Strathclyde St., GLASGOW, S.E.

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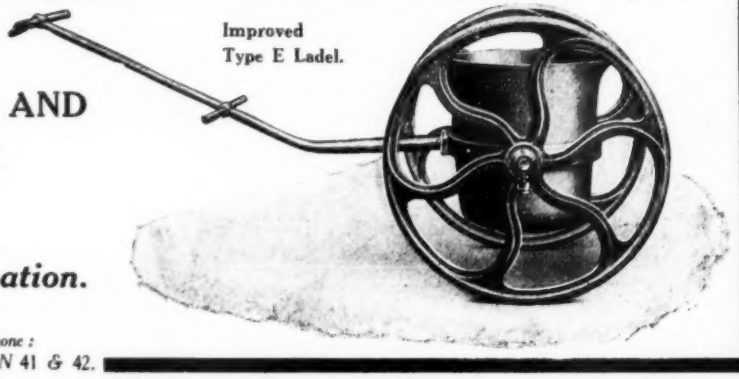

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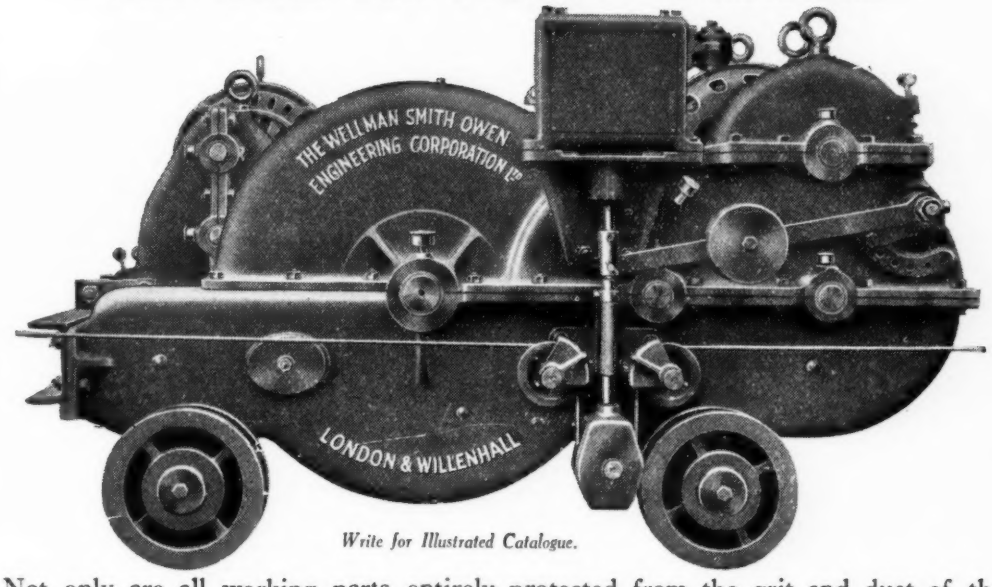

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Not only are all working parts entirely protected from the grit and dust of the atmosphere, but the efficient lubrication and smooth running which can be obtained are highly conducive to long life of the Crane.

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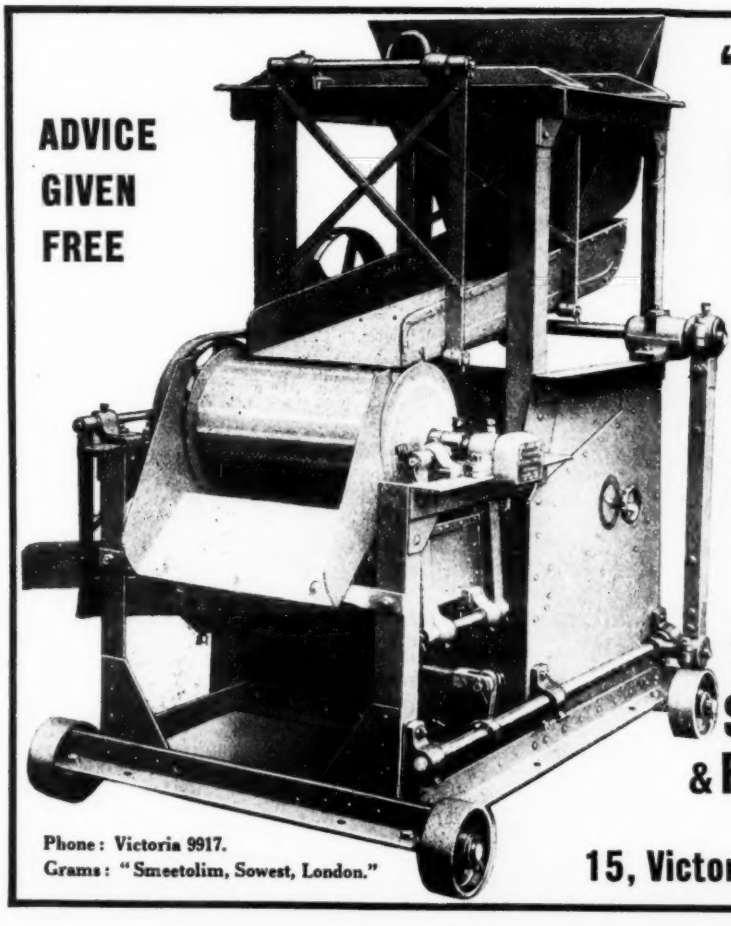

"STEINERT" (PATENT) MAGNETIC IRON SEPARATORS

The machine you will eventually install to save money, time and labour.

All types made of high class materials, soundly constructed and absolutely efficient.

Sole British Selling Agents :—

THE BRITISH SCHURMANN CUPOLA & FOUNDRY EQUIPMENT CO., LTD.,

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Grams : "Smeetolim, Sowest, London."

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	61	10	0
Three months	62	10	0
Electrolytic	67	10	0
Tough	64	0	0
Best selected	64	10	0
Sheets	93	0	0
India	81	0	0
Wire bars	68	10	0
Do. Sept.	68	0	0
Do. Oct.-Nov.	68	2	6
Ingot bars	68	0	0
H.C. wire rods	72	10	0
Off. av. cash, Aug.	62	13	6
Do., 3 mnths. Aug.	63	13	0
Do., Sttlmnt, Aug.	62	13	4½
Do., Electro, Aug.	68	7	9
Do., B.S., Aug.	66	3	1½
Aver. spot price copper, Aug.	62	13	4½
Do., wire bars, Aug.	68	12	1½
Solid drawn tubes		13¼d.	
Brazed tubes		13¼d.	
Wire		10d.	

BRASS.

Solid drawn tubes	12d.
Brazed tubes	13½d.
Rods, drawn	11⅞d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	10¾d.
Wire	10½d.
Rolled metal	9¾d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

	£	s.	d.
Standard cash	264	5	0
Three months	264	10	0
English	264	5	0
Bars	263	15	0
Straits	268	12	0
Australian	265	12	6
Eastern	269	10	0
Banca	267	7	6
Off.aver.cash, Aug.	258	12	8½
Do., 3 mths., Aug.	258	6	6¾
Do., Sttlmt. Aug.	258	13	0
Aver. spot., Aug.	258	13	0

SPELTER.

	£	s.	d.
Ordinary	38	5	0
Remelted	37	5	0
Hard	31	10	0
Electro 99.9	42	2	6
English	38	5	0
India	32	10	0
Zinc dust	43	0	0
Zinc ashes	15	0	0
Off. aver., Aug.	36	9	1⅛
Aver., spot, Aug.	36	13	9

LEAD.

	£	s.	d.
Soft foreign ppt.	39	12	6
English	41	0	0
Off. average, Aug.	37	8	4½
Average spot, Aug.	38	3	9

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	43	10	0
Do. V.M. ex whf.	43	0	0
Rods	49	0	0
Boiler plates	42	0	0
Battery plates	42	0	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	74	10	0
Chinese	66	0	0
Crude	57	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	13	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro silicon 45/50%	£12 10 0
75%	£21 0 0
Ferro-vanadium— 35/40%	16/- lb. va.
Ferro-molybdenum— 70/75% c. free	6/6 lb.
Ferro-titanium— 23/25% carbonless	1/1 lb.
Ferro-phosphorus, 20/25%,	£22 0 0
Ferro-tungsten— 80/85% c.fr.	1/8 to 1/8½ lb.
Tungsten metal powder— 98/99%	1/11 to 1/11½ lb.
Ferro-chrome— 4/6% car.	£23 7 6
6/8% car.	£23 0 0
8/10% car.	£22 10 0
Ferro-chrome— Max. 2% car.	£39 10 0
Max. 1% car.	£51 10 0
Max. 0.70% car.	£56 10 0
70% carbonless	1/5 lb.
Nickel—99% cubes or pellets	£170 to £175
Cobalt metal—98/99%	10/- lb.
Aluminium 98/99%	£118
Metallic Chromium— 96/98%	3/9 lb.
Ferro-manganese (net)— 76/80% loose	£15 7 6
76/80% packed	£16 7 6
76/80% export	£15 5 0
Metallic manganese— 94/96% carbonless	2/- lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares 3 in. and over	4d. lb.
Rounds and squares under ½ in. to ¼ in.	3d. lb.
Do. under ¼ in. to ⅜ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do. under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length 10% extra

Scrap from high-speed tool steel—

Scrap pieces	3d.
Turningds and warf	1d.

Per lb. net, d/s steel makers' work

SCRAP.

	£	s.	d.	£	s.	d.
South Wales— Hvy. steel	3	6	0	to 3	7	6
Bundled steel & shrngs.	3	1	0	to 3	5	0
Mixed iron & steel	2	18	0	to 3	2	0
Heavy cast iron				3	5	0
Good machinery for foundries				3	10	0
Cleveland— Heavy steel				2	17	6
Steel turnings				2	3	0
Cast iron borings				2	0	0
Heavy forge				4	0	0
Bushelled scrap				3	4	0
Cast-iron scrap	3	7	6	to 3	11	0
Lancashire— Cast-iron scrap	3	10	0	to 3	12	6
Heavy wrought				3	7	6
Steel turnings				2	3	0

London — Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	53	0	0
Brass (clean)	40	0	0
Lead (less usual draft)	33	10	0
Tea lead	29	10	0
Zinc	24	0	0
New aluminium cuttings	92	0	0
Braziery copper	48	0	0
Gunmetal	48	0	0
Hollow pewter	175	0	0
Shaped black pewter	128	0	0

PIG-IRON.

(f.o.t. unless otherwise stated).

N.E. Coast— Foundry No. 1	71/6
Foundry No. 3	67/6
Foundry No. 4	66/6
Forge No. 4	66/-
Hematite No. 1	75/-
Hematite M Nos.	74/6
N.W. Coast— Hem. M Nos. d/d Glas.	85/-
,, d/d Birm.	92/6
Midlands— Staffs. common*	—/—
,, No. 4 forge	67/6
,, No. 3 foundry	69/-
Shrops. basic	70/-
,, Cold blast, ord.*	185/-
,, ,, roll iron*	190/-
* d/d Birmingham.	
Northants forge	57/6
,, fdry No. 3	62/-
Derbyshire forge	59/6
,, fdry. No. 3	66/3
,, basic	67/6
Scotland— Foundry No. 1	85/-
,, No. 3	80/-
Hem. M Nos.	81/6
Sheffield (d/d district)— Derby forge	63/3
,, fdry. No. 3	70/6
Lincs. forge	69/-
,, fdry. No. 3	72/-
E.C. hematite	84/6
W.C. hematite	87/6
Lincs. (at furnaces)— Forge No. 4	63/-
Foundry No. 3	66/-
Basic	63/6
Lancashire (d/d eq. Man.)— Derby forge	67/-
,, fdry. No. 3	74/-
Northants foundry No. 3	75/-
Dalzell, No. 3	110/-
Summerlee, No. 3	98/-
Glengarnock, No. 3	98/-
Gartsherrie, No. 3	98/-
Monkland No. 3	98/-
Coltness, No. 3	98/-
Shotts, No. 3	98/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

	£	s.	d.	£	s.	d.
Iron— Bars(cr.)	11	12	6	to 12	10	0
Angles				12	7	6
Tees to 3 united ins.				13	2	6
Nut and bolt				11	0	0
Hoops	14	0	0	to 15	0	0
Marked bars (Staffs.) f.o.t.				14	10	0
Gas strip				12	15	0
Bolts and nuts ⅝ in. × 4 in.				16	15	0
Steel— Ship plates	8	0	0	to 8	15	0
Boiler plts.				12	0	0
Chequer plts.	£9	15	0	to 10	5	0
Angles	£7	15	0	to 8	5	0
Tees	£8	15	0	to 9	5	0
Channels	£7	5	0	to 7	15	0
Joists	£7	15	0	to 8	5	0
Rounds and Squares 3 in. to 5½ ins.				9	0	0
Rounds under 3 in. to ⅜ in.				8	15	0
Flats, over 5 in. wide and up				9	10	0
Flats, 5in. to 1½in.				8	10	0
Rails, heavy				8	10	0
Fishplates				12	10	0
Hoops (Staffs.)				10	10	0
Black sheets, 24g.				11	5	0
Galv. cor. sheets, 24g.				16	5	0
Galv. fencing wire 8g. plain				14	0	0
Billets, soft	£6	7	6	to 7	15	0
Billets, hard				9	0	0
Sheet bars	£6	5	0	to 6	15	0
Tin bars d/d	£6	5	0	to 6	15	0

PHOSPHOR BRONZE.

	Per lb.	basis.
Strip	1	3
Sheet to w.g.	1	3½
Wire	1	3¾
Rods	1	3
Tubes	1	8
Castings	1	2

Delivery 3 cwt. free

10% phos. cop. £40 above B.S.

15% phos. cop. £50 above B.S.

Phosphor tin (5%) £30 above price of English ingots.

C. CLIFFORD & SONS, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising 9d. to 1/3	
Rolled— To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round— 3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwis. stated. Dolse

No. 2X foundry, Phila.	21.76
No. 2 foundry, Valley	20.26
No. 2 foundry, Birm.	18.50
Basic	19.76
Bessemer	20.76
Malleable	20.26
Grey forge	19.76
Ferro-mang. 80% d/d	115.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	35.00
O.-h. billets	35.00
O.-h. sheet bars	35.00
Wire rods	45.00

Cents.

Iron bars, Phila.	2.12
Steel bars	1.90
Tank plates	1.80
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.40
Sheets, black, No. 28	3.15
Sheets, galv., No. 28	4.20
Sheets, blue an'l'd, 9 & 10	2.25
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv.	3.35
Tinplate, 100 lb. box	£5.50

COKE (at ovens).

Welsh foundry	37/6
,, furnace	27/6
Durham & North. ,, foundry	35/-
,, furnace	15/-
Other Districts, foundry	35/-
,, ,, furnace (Basis)	13/6

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes, 20×14, box	19/4½
,, 28×20, ,,	38/9
,, 20×10, ,,	28/4½
,, 18⅞×14, ,,	20/4½
C.W. 20×14, ,,	18/-
,, 28×20, ,,	36/3
,, 20×10, ,,	25/-
,, 18⅞×14, ,,	18/6

Terneplates 28×20, 35/9 per box basis f.o.b.

SWEDISH IRON.

Bars, hammered	£19/0 to £20/0
Rolled Ord.	£16/0/0 to £16/10/0
Nail rods	£16 5 0 to £16 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£10 to £14

Pig-iron £6 15 0 to £7 0 0 all f.o.b. Gothenburg.

TUBES.

	Up to and incl. 6 in.
Gas	55%
Water	50%
Steam	45%

Tube prices are now free.

DAILY FLUCTUATIONS.

Standard Copper (Cash).

	£	s.	d.	
Sept. 17	62	0	0	dec. 10/–
,, 18	61	15	0	,, 5/–
,, 21	62	0	0	inc. 5/–
,, 22	61	15	0	dec. 5/–
,, 23	61	10	0	,, 5/–

Electrolytic Copper.

	£	s.	d.	
Sept. 17	68	0	0	dec. 10/–
,, 18	67	15	0	,, 5/–
,, 21	68	0	0	inc. 5/–
,, 22	68	0	0	No change
,, 23	67	10	0	dec. 10/–

Standard Tin (Cash).

	£	s.	d.	
Sept. 17	260	10	0	dec. 5/–
,, 18	260	2	6	,, 7/6
,, 21	262	0	0	inc. 37/6
,, 22	261	12	6	dec. 7/6
,, 23	264	5	0	inc. 52/6

Tin (English ingots).

	£	s.	d.	
Sept. 17	260	15	0	dec. 5/–
,, 18	260	5	0	,, 10/–
,, 21	262	5	0	inc. 40/–
,, 22	261	15	0	dec. 10/–
,, 23	264	5	0	inc. 50/–

Zinc Sheets (English).

	£	s.	d.	
Sept. 17	43	10	0	No change
,, 18	43	10	0	,, ,,
,, 21	43	10	0	,, ,,
,, 22	43	10	0	,, ,,
,, 23	43	10	0	,, ,,

Spelter (ordinary).

	£	s.	d.	
Sept. 17	37	3	9	No change
,, 18	37	6	3	inc. 2/6
,, 21	37	12	6	,, 6/3
,, 22	37	17	6	,, 5/–
,, 23	38	5	0	,, 7/6

Lead (English).

	£	s.	d.	
Sept. 17	40	5	0	inc. 5/–
,, 18	41	0	0	,, 15/–
,, 21	41	15	0	,, 15/–
,, 22	41	5	0	dec. 10/–
,, 23	41	0	0	,, 5/–

Exports of Iron Castings in August and the eight months, 1925 compared with August and the eight months, 1924.

	August, 1924.	August, 1925.	Eght months, 1924.	Eight months, 1925.	August, 1924.	August, 1925.	Eight months, 1924.	Eight months, 1925.
BUILDERS' CASTINGS—								
Stoves, Grates, etc., Cisterns, Baths, etc., and cooking and washing boilers:—	Tons.	Tons.	Tons.	Tons.	£	£	£	£
To Argentine Republic	145	167	929	1,044	4,714	5,899	33,434	38,534
,, British South Africa	271	221	2,241	2,456	8,513	7,430	77,359	86,633
,, ,, East Indies	120	174	907	1,181	4,206	7,295	38,949	54,543
,, Australia	52	72	498	483	2,824	4,617	28,208	27,214
,, New Zealand	100	269	1,334	1,869	5,001	11,529	64,447	86,199
,, Other countries	587	641	4,333	5,104	30,819	30,993	218,173	257,712
Total	1,275	1,544	10,242	12,137	56,077	67,763	460,570	550,835
PIPES AND FITTINGS—								
Cast—								
To Argentine Republic	971	1,406	5,487	8,402	12,579	17,873	74,475	107,167
,, British South Africa	389	332	5,596	4,855	6,301	5,866	71,602	68,791
,, ,, India	1,094	571	8,098	6,754	15,798	8,152	120,123	95,570
,, Straits Sttlmts. & Malay States	611	243	6,782	4,224	6,974	3,169	85,826	50,292
,, Ceylon	46	49	704	901	585	776	9,611	11,315
,, Australia	179	93	3,073	2,229	3,078	1,606	47,116	35,220
,, Other countries	4,837	4,768	27,498	37,640	84,761	63,752	467,271	552,463
Total	8,127	7,462	57,238	65,005	130,076	101,194	876,024	920,818
HOLLOW-WARE—								
Cast, not Enamelled, & Cast, Tinned	566	638	4,277	5,466	22,389	20,461	171,696	183,062
,, Enamelled	59	66	714	679	6,778	8,481	74,535	69,850
CASTINGS, in the rough—								
Iron	228	198	1,005	1,070	8,676	4,637	41,098	37,202
Steel	61	40	1,926	474	1,927	2,087	34,254	19,415

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

18, BENNETTS HILL, BIRMINGHAM.
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